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Use of Cooperative Learning and Computer Assisted Instruction to Investigate Mathematics Achievement Scores, Student's Attitude toward Cooperative Learning and Confidence in Subject Matter

Kathy R. Griffin

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USE OF COOPERATIVE LEARNING AND COMPUTER ASSISTED INSTRUCTION
TO INVESTIGATE MATHEMATICS ACHIEVEMENT SCORES, STUDENT'S
ATTITUDE TOWARD COOPERATIVE LEARNING AND
CONFIDENCE IN SUBJECT MATTER

A Dissertation

Submitted to the School of Education

Instructional Leadership Excellence at Duquesne

Duquesne University

In partial fulfillment of the requirements for
the degree of Doctor of Education

By

Kathy R. Griffin

May 2008

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2008

DUQUESNE UNIVERSITY
SCHOOL OF EDUCATION
Department of Instruction and Leadership

Dissertation

Submitted in Partial Fulfillment of the Requirements

For the Degree of Doctor of Education (Ed.D.)

Instructional Leadership Excellence at Duquesne

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STUDENT'S ATTITUDE TOWARD COOPERATIVE LEARNING AND
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ABSTRACT

USE OF COOPERATIVE LEARNING AND COMPUTER ASSISTED INSTRUCTION TO INVESTIGATE MATHEMATICS ACHIEVEMENT SCORES, ATTITUDE TOWARD COOPERATIVE LEARNING, AND CONFIDENCE IN SUBJECT MATTER

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Kathy R. Griffin

May 2008

This study investigated mathematics achievement scores between students working in cooperative learning groups using computer assisted instruction (CAI), and students working alone using CAI in a post-secondary developmental mathematics class. Fifty-one students enrolled in a basic mathematics course participated in the study. Two classes were assigned to work alone using CAI, and two classes were assigned to work in cooperative pairs using CAI. This study was a pre-post-test design, and was administered to all participants to determine their mathematics achievement scores.

A survey using a 5 point Likert Scale further examined if using cooperative learning and CAI would change students' attitude towards their confidence in the subject matter, their attitude towards working in cooperative learning groups.

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Chapter 1

Introduction

This study is designed to examine whether mathematics achievement scores in a college-level developmental mathematics class will increase when cooperative learning and computer-assisted instruction (CAI) are utilized. The study will also attempt to determine if the cooperative use of computers can change students' attitude towards mathematics, as well as their attitude towards working in cooperative learning groups. The students involved in this study have limited arithmetic skills.

Developmental Education

Studies have confirmed that increasing numbers of students come to college unprepared to satisfactorily complete college level mathematics (Anderson & MacClenny, 2001; Gardner, 1994; McCabe & Day, 1998). A recent study revealed that 100% of the nation's community colleges and 78% of all higher education institutions offered at least one developmental course in reading, writing or mathematics (Lewis and Farris 1996; Moylan, Bonham, Claxton & Bliss, 1992; NCES, 2003;). Furthermore, fifty-five percent of community colleges reported an increase in the number of students enrolled in developmental courses over the previous five years (Kozieracki, 2002).

There are many reasons that make instruction more challenging for developmental mathematics students including: high variability of age, prior background, poor study skills, a history of frustration in mathematics, and a lack of purpose for learning mathematics (Hardin, 1998; Higbee & Dwinnel, 1998, Knopp, 1996

Research on instructional methods for developmental students has produced no single method as a panacea for the many learning problems encountered by these students (Boylan, Bonham, Claxton, & Bliss, 1992; McCabe, 2000; McCabe & Day, 1998; Silverman & Casazza, 1999). Despite the myth that mathematical principles are fixed for all time, new discoveries and theories about mathematics continue to emerge, and the uses of mathematics in the world evolve, which include the use of computers (Bishop et al., 1993).

Computer Assisted Instruction

Computer assisted instruction (CAI) most often refers to drill and practice, tutorial, or simulation activities offered either by themselves or to supplement traditional teacher directed instruction. The use of technology is one of the elements recommended for developmental mathematics program to support teaching and learning (McCabe & Day, 1998; Darken, 1995). In a study by Li and Edmonds (2005) on the effects of CAI on adult at-risk learners in a fundamental mathematics program discovered positive gains in various achievement tests, which suggests that at-risk adult learners benefit academically in some areas with the use of CAI. However, in a study of Chinese Taipei adolescent students, House (2002) found there was a significant negative relationship between the use of computers and mathematics achievement. House concluded there is a tendency for students to earn lower mathematics test scores when teachers more frequently use computers to demonstrate mathematics ideas during classroom lessons.

Instructional Methods

Many instructors in higher education are not happy with their current teaching style, which is typically lecture or lecture with discussion (Panitz, 1999). This type of

instruction leads to distance between faculty and students, fragmentation of the curriculum, prevailing pedagogy of lecture and routine tests, educational culture that reinforces student passivity, high rates of student attrition and a reward system that gives low priority to teaching (Smith and MacGregor, 1992).

In 1999, Grubb stated that the most frequent approach to classroom instruction was lecture followed by “drill and kill” activities. If college faculty were to use the lecture method less often and use cooperative learning techniques more often, passivity among students would decrease by allowing them to be in charge of their own learning (Cuseo, 1996).

The use of cooperative learning allows all students, not just the more assertive or more verbal students, to become more involved with the course material and with each other as they actively work together in small groups (Cuseo, 1996). Cooperative learning promotes greater opportunities for students to get to know each other and develop friendships than does competing with others or working alone. This is particularly important for students from different ethnic, cultural, language, social class, ability, and gender groups (Johnson, Johnson, Maruyama, Nelson & Skon, 1981). Academic success is, above all, the college’s aim and the student’s goal. Success also affects attrition rates; the more students achieve, the more committed they tend to be in completing college (Johnson, Johnson, & Smith, 1998).

Cooperative Learning

Cooperative learning is the instructional use of small groups from two to four students to maximize their own and each other’s learning (Johnson, and Johnson, 1989). Cooperative learning is a structured, systematic instructional strategy in which small groups of

students work together toward a common goal. In order to ensure consistent positive effects on achievement, certain elements must be in place. Two of those elements include positive interdependence and individual accountability (Johnson and Johnson, 1989).

Although students work together in groups for some percentage of their class work, course grades are primarily determined by tests that are completed independently. Individual accountability may lower the sense of inequity perceived by many in traditional small group procedures, where one or two of the team members have done most of the work. Small group instruction that does not contain these two features should not be termed cooperative learning (Cooper, Robinson, & McKinney, 2002

Cooperative Learning and Technology

Studies were conducted by Crooks, Klein, Leader, and Savenye (1998) where the participants were randomly assigned to either the cooperative-learning or individual-learning condition, using CBI. It was found that variations in instructional method and learner-control mode had no effect on student performance on the post-test, which assessed learning of the information presented in the CBI program. Similar results were also found by Brinkerhoff, Brush, & Klein 2005.

Differences were found, however, in their attitudes toward the instructional method. Compared with students who worked alone, students in the cooperative dyads expressed a significantly greater preference for working with another student to learn content presented by a computer. Results of this study suggest the achievement benefits attributed to cooperative learning in studies with younger children may not apply when adults use cooperative learning with CBI (Crooks, Klein, Leader, & Savenye 1998).

In another study by Wang, Hinn, and Kanfer (2001) that measured the effects of learning styles with regard to computer supported programs. The results failed to indicate a significant relationship between students' learning outcomes in a cooperative learning setting.

Rationale

A review of previous studies found that there are no studies involving cooperative learning and computer assisted instruction in a developmental mathematics classroom, and there are only a few recent studies involving cooperative learning and CAI in higher education (Crooks, Klein, Leader, & Savenye 1998; Brinkerhoff, Brush, & Klein 2005; Wang, Hinn, & Kanter 2001). These studies do not include mathematics and more specifically, developmental mathematics. The studies that have been reported in the literature used a post-test only design making a determination of whether or not the students were academically equal in the beginning impossible to determine.. The instruments used were undoubtedly different as well. The current studies used only a post-test design, and the use of an attitudes survey that measured the attitudes of mathematics and cooperative learning was not mentioned in any of the studies. Finally, none of the studies mention the type of cooperative learning that was used or the use of journaling at the end of the class sessions. As a result, this study will investigate whether mathematics achievement scores will increase as a result of using cooperative learning and computer assisted instruction (CAI). Also, the study will attempt to determine if attitudes towards cooperative learning will be different, as well as attitudes towards confidence in subject matter as a result of working in cooperative learning groups using CAI?

Hypotheses

- Developmental mathematics students who work in cooperative learning groups using computer assisted instruction achieve higher scores than those who work alone using computer assisted instruction.
- Developmental mathematics students who work in cooperative learning groups using computer assisted instruction achieve a more positive attitude towards cooperative learning than students working individually using computer assisted instruction.
- Developmental mathematics students who work in cooperative learning groups using computer assisted instruction achieve a more favorable attitude towards mathematics than students working individually using computer assisted instruction.

Definition of Term

Computer Assisted Instruction: For the purpose of this study, computer assisted instruction refers to the drill and practice students receive on the computer as a supplement to traditional teacher directed instruction..

- Technology Supported Cooperative Learning: The instructional use of technology is combined with the use of cooperative learning groups.
- Competitive Learning: Students working to achieve goals that only a few can attain; students can succeed if and only if the other students in the class fail to obtain their goals.
- Cooperative or Collaborative Learning: For the purpose of this study, cooperative learning refers to the students who work in pairs using a spiral bound notebook to solve

mathematical problems presented to them using computer assisted instruction, and then comparing their answer with their partner forming a consensus before putting their answer into the computer. Additionally, students' use their notebooks to write a reflection on the lessons they have accomplished during the computer assisted instructional session. There are 27 participants in the cooperative learning group and 24 participants who worked alone.

- Numeracy One view equates numeracy with basic computational skills. Another view of numeracy focuses on people's capacity and propensity to effectively and critically interact with the quantitative aspects of the adult world (Gall, 2000). For the purpose of this dissertation numeracy is defined as basic computational skills.

- Developmental Education, Remedial Education, and Basic Skills Instruction:

Developmental Education programs and services commonly address academic preparedness, diagnostic assessment and placement, development of general and discipline-specific learning strategies, and affective barriers to learning. (National Association of Developmental Educators, 2002).

- Under-prepared students: For the purpose of this study an under-prepared student is an individual attending The Art Institute of Pittsburgh who scored 65 or below on the Accuplacer pre-test and is placed in the MTH099 mathematics course, which is basic mathematics or arithmetic.

There are three reasons why The Art Institute of Pittsburgh was chosen for this study.

- The Art Institute of Pittsburgh operates on the quarter system. Each quarter; approximately 45% of enrolled students require developmental courses.

- The Art Institute of Pittsburgh has two levels of developmental mathematics; MTH099 is basic mathematics or arithmetic, which is the focus of this study.
- Students who are enrolled at The Art Institute of Pittsburgh are enrolled in Art Programs and not programs found in traditional colleges or universities. The programs offered at The Art Institute of Pittsburgh are: Advertising, Culinary Arts, Culinary Management, Digital Media Production, Game Art and Design, Graphic Design, Interior Design, Media Arts and Animation, Photography, Video Production, and Visual effects and Motion Graphics.

Delimitations of the Study

For the purpose of this study, only students enrolled in MTH099 basic mathematics are eligible to participate. Also, only four of the five classes scheduled will take part in the study, so there will not be an abundance of students in one group compared to the other group.

Limitations of the Study

Classes are scheduled by department directors, there was no control on the time classes would occur. Ideally all classes involved in the study would take place at similar times during the day, however, two of the classes met twice a week for two hours and two classes met once a week for four hours. The two classes that met twice a week met early afternoon, while the four hour classes began at 6:00 p.m.

Two classes will be assigned to the cooperative learning groups using computer assisted instruction and two classes will be assigned to work individually using computer assisted instruction. The fifth class will not be part of the study and will be conducted

using a regular class structure. The exclusion of the fifth class is due in large part to the logistics of the room setup, and to keep the number in each group more equal.

Finally, the researcher was also the instructor during the lecture and the computer portion of the class for each of the groups during the study. Implications of this could be providing more information or assistance to one group than the other group. However, all precautions were taken to ensure each class received the same instruction with the same number of examples and the same examples during the lecture, and assistance was given during the computer portion of the study only if it were impossible for the student to move ahead successfully on his or her own.

CHAPTER 2

REVIEW OF LITERATURE

Developmental Education

Developmental education is a comprehensive process which focuses on the intellectual, social and emotional growth and development of all learners. It includes but is not limited to tutoring, personal and career counseling, academic advisement, and coursework (NADE Executive Board, 1998). Students come to colleges with a variety of characteristics, and those attending for the first time are sometimes inadequately prepared both academically and psychologically for what will be expected for college level learning (Howell, 2001). Institutions of higher learning have been accepting students who may not have met their admission standards for almost 200 years, and at the same time, have also been developing ways to meet the needs of these diverse learners (Brubacher & Rudy, 1976; Casazza & Silverman, 1996)

Studies confirm that more and more students come to college unprepared to tackle college level mathematics (Anderson & McClenney, 2001; Gardner, 1994; McCabe & Day, 1998). In a report by Boylan, Bonham, Claxton & Bliss, (1992) over 90% of the nation's community colleges and approximately 70% of universities offered developmental courses in mathematics. In a later report, Lewis and Farris (1996) stated that, 100% of community colleges and 78% of all higher education institutions offered at least one developmental course in reading, writing or mathematics. Most recently, The National Center for Education Statistics (NCES), (2003) reported that developmental education was offered in 98% of two-year public, and 80% of 4-year public institutions.

Of these, 71% of public and 59% of the private colleges offer developmental mathematics (NCES, 2003). Of the freshman students who are enrolling in two-year colleges, 42% require at least one developmental class compared with 12 to 24% at other types of institutions. In addition, public 4-year institutions had a higher proportion of freshmen enrolling in at least one remedial reading, writing, or mathematics course than did private 4-year institutions (NCES, 2003). Kozeracki, (2002) stated that 55% percent of community colleges reported an increase in the number of students enrolled in developmental courses over the previous five years. According to NCES (2003), 28% of students entering colleges and universities require developmental courses in English, reading, or mathematics. Thirteen percent of all undergraduates or 1.6 million students report having taken one or more developmental courses in college (Knopp, 1996). It was reported, however, that just over half of the students graduating from high school in 1994 took a complete battery of college preparatory courses. (NCES, 1996).

Certain characteristics are identified which lead to a successful developmental education program. Mandatory assessment, mandatory placement, and trained tutors are among the common characteristics of a successful program (Boylan, Bonham, & Bliss, 1994; McCabe & Day, 1998). Students participating in programs featuring mandatory assessment are much more likely to pass their first developmental English or mathematics courses than students in programs where assessment is voluntary (Boylan et al, 1994).

Numeracy or mathematics is a course many institutions have implemented as a developmental class (Armington, 2002). One fact that has not changed is that the greatest need for remediation is still in the area of mathematics. Armington further reports that half of all students enrolled in a developmental class participate in remedial mathematics.

. The Third International Mathematics and Science Study (TIMSS), report that 36 countries participated in the study and the United States mathematics literacy is below average compared to all of the countries involved in the study (Stephens, & Coleman, 2007). The downward trend in mathematics proficiency has been consistent since 1957 (Goodstein 2001). However, according to Stephens and Coleman (2007), there was no change in mathematics literacy scores from the TIMSS study in 2003 and the TIMSS study in 2006.

Teaching developmental mathematics differs a great deal from teaching college level mathematics. Developmental instruction addresses not only the remediation of subject-specific deficiencies, but motivational and learning deficiencies as well. Some of this is due in part because the population of students entering college at the developmental level differs from traditional student population (Armington, 2002).

One study reports that 40% of high school students who completed college preparatory courses and then immediately enrolled in a two-year college required developmental mathematics (Waycaster, 2001). Burley, Burner, & Cejda (2001) reported that 68% of first time college freshmen needed developmental coursework. Twenty-six percent had deficiencies in mathematics, reading and writing, while an additional 25% had deficiencies only in mathematics. The authors suggest that most students' deficiencies tend to be in mathematics, which tends to be the most difficult area to remediate.

Kroesbergen and Van Luit (2003) conducted a meta-analysis on the characteristics of the most effective interventions with students of special needs and general education, and found that basic mathematics skills appears to be a domain in which interventions are

effective. They described interventions as effective when the students acquire the knowledge and skills being taught and adequately apply this information on a post-test. They concluded that it might be easier to teach basic skills to students with special needs than to teach problem solving skills. Both self-instruction and direct instruction seem to be adequate methods for students with special needs.

The characteristic of being under-prepared is usually measured by SAT scores or ACT tests. Developmental students usually fall into the bottom half of score distribution on these instruments (Boylan, 1999). It is important to understand the type of person a developmental student may be.

According to Armington (2002) there are five categories in which to classify a developmental student.

- First, in the area of developmental math, some are capable students who have simply fallen behind, not for a lack of ability, but because they are not interested, insufficient effort, lack of seriousness, or some similar reason.
- A second category of developmental mathematics student can be described as those who are adequately prepared for college level study, but have a specific weakness in mathematics. These students typically perform well in college level subjects outside of mathematics, but have difficulty mastering developmental level concepts in mathematics.
- Third, students who are motivated to pursue college level work, but are deficient in generalized learning skills as well as mathematics-specific skills. A fair number of these students can succeed if the developmental environment provides strong support in the learning skills as well as academic content areas.

- Fourth, these students have verifiable usually documented learning disabilities. Special accommodations or alternate instructional methodologies may be necessary for some of these students to succeed.
- The fifth, group is comprised of students who have a broad range of deficiencies in multiple areas including mathematical abilities, learning skills, motivation, organizational skills and others. Students in this category will have difficulty succeeding even when the programmatic aspects of developmental instruction are at their strongest.

Mathematics

Quantitative skills traditionally are viewed as a basic skill area one of the three R's.

The literacy act of 1991 states:

“Literacy is an individual’s ability to read, write and speak in English and to compute and solve problems at levels of proficiency necessary to function on the job and in society, to achieve one’s goals, and develop one’s knowledge and potential.” “The literature tells us adult basic skills include reading, writing and computation. Therefore, numeracy and literacy need to be viewed as interrelated, but distinct.”

Contextualized mathematics applies a constructivist approach to learning, in which the students relate new knowledge to what they already know, construct their own understanding, and make new meanings. This approach can help learners recognize the mathematics characteristics of everyday situations (Gal, 1992). Educators can empower learners with the numeracy skills needed to function in the technological society and workplace. For those who have difficulty learning these skills, developmental mathematics courses may provide the solution for students to be successful in college courses.

Developmental mathematics courses normally serve multiple purposes. The primary goal is to remediate student deficiencies in mathematical skills, which are prerequisite to success in required college level mathematics, as well as courses in the sciences, business or other fields that require basic mathematics and algebra competencies (Armington, 2002). Another purpose of developmental courses, especially mathematics courses is to serve as part of the mechanism by which colleges eliminate students who are not qualified for further study. The fact that developmental mathematics courses play this role gives rise to two contradictory considerations. On the one hand these courses are intended to assist students in meeting college qualifications by overcoming their deficiencies, while on the other hand they are intended to eliminate students who are not qualified to continue (Armington, 2002). According to studies, two issues appear to hinder success in developmental mathematics classrooms: attitudes and anxiety.

Attitude Towards Mathematics

There is an assumption among many mathematics educators that negative student attitudes toward developmental mathematics impact negatively upon classroom performance. Berensen, Carter, & Norwood (1992) found 32% of at risk students had negative attitudes and 47% had neutral attitudes towards mathematics; only 21% had positive attitudes towards mathematics. Along the spectrum are students who are afraid of mathematics and students who resent being placed in a developmental class (Fiore, 1999; Tobias, 1993; Williams, 1998). By empowering students with a positive attitude with respect to the required remediation, the student's chances of success are greatly increased (Hammerman and Goldberg, 2003). The correlation between a student's attitude and success with mathematics is confirmed by research (Cornell, 1999; Fiore,

1999; Lester, Garofalo & Kroll, 1989; Meece, Wigfield, & Eccles, 1990; Neale, 1969; Silver, 1985). However, Wacek (2002) found a low correlation between attitudes towards mathematics and students' grades. Wacek collected and analyzed data from a four semester study of 1,506 students to determine the success and attrition rates in developmental mathematics courses. She concluded that the correlation coefficients obtained from the study were so low that prejudging a students' grade based on his or her feelings may not be practical. Wacek also determined that instructors should not equate bad attitudes toward mathematics with a road to failure.

According to Tobias (2001) the predominant causes of mathematics anxiety are environmental factors created by mathematics teachers. These include pressures created by timed tests, an overemphasis on one right method and one right answer, humiliation of students at the blackboard, an atmosphere of competition, absence of discussion, and other related dynamics that typify the mathematics classroom. Tobias further states, for many students, these factors lead to destructive self-beliefs about the mathematical abilities they possess, avoidance behavior, and an unwillingness to explore mathematical concepts in the classroom environment. Coupled with the negative influence of environmental factors is the belief that students who do well in mathematics do so because of native ability, not effort. This misconception, propagated by teachers and society at large, only serves to reinforce negative student behaviors that lead to underperformance in mathematics.

Tobias (2001) further identifies what she terms as a mismatch between students' learning characteristics and instructors' teaching styles in mathematics. Tobias states only a small percentage of students have the ability to easily solve and process mathematical

problems. The rest of the students, have learning style preferences or needs that do not fit traditional modes of mathematics instruction. Specifically, students who are high verbal performers need discussion and choice; utilitarian learners need predictable learning patterns, and under prepared students need periodic clarification with respect to weaknesses in prior content areas. The typical mathematics instructor uses traditional methods of instruction, which include chalkboard, marker board, or overhead presentations, and the instructor presenting course material through lecture and demonstration of concepts (McClory, 2002; Zaslavsky, 1994). Despite the myth that mathematical principles are fixed for all time, new discoveries and theories about mathematics continue to emerge, and the uses of mathematics in the world evolve, which include the use of computers (Bishop et al., 1993).

Computer-Based Education, Computer-Based Instruction and Computer Aided Instruction

Computer-based Education (CBE) and Computer-based Instruction (CBI) are the broadest terms and can refer to virtually any kind of computer use in educational settings, including drill and practice, tutorials, simulations, instructional management, supplementary exercises, programming, database development, writing using word processors, and other applications (Cotton, 2001). These terms may refer either to stand-alone computer learning activities or to computer activities that reinforce material introduced and taught by teachers. Computer Assisted Instruction (CAI) is a narrower term and most often refers to drill and practice, tutorial or simulation activities offered either by themselves or to supplement traditional teacher-directed instruction (Cotton, 2001).

Edwards, 1993; Eom & Reiser, 2000; Finnigan & Sinatra, 1991; Osei, 2001; and Worthington, 1993, have found CAI has positive benefits for adult students. In discussions concerning CAI a frequently asked question among scholars is, “Is it better than text or lecture based instruction?” In regard to remedial or developmental education, the results have been positive (Keup, 2001). In a study by Li, and Edmonds (2005) on the effects of CAI on adult at-risk learners in fundamental mathematics education, they found positive gains in various achievement tests including three paper and pencil tests, and two on-line quizzes, which suggests that at-risk adult learners benefit academically in some areas with the use of CAI.

Computer assisted instruction is utilized because of the benefits it offers to adult learners. It offers privacy, patience, feedback, individualization, control and flexibility, convenience, and a non-threatening learning environment for students (Wilson, 1992; Osei, 2001 Eom, & Reiser, 2000). Most adult learners do not want others to know about their academic deficiencies. They also take errors more personally and allow mistakes to affect their self-esteem (Osei, 2001). CAI not only provides privacy, the computer is non judgmental and allows low-level ability students to work on improving their skills without divulging their ability level to classmates (Edwards, 1993; Learning with Computers, 1991; Worthington, 1993).

During CAI instruction, students’ responses are not timed, so students can move at their own pace. Using CAI also allows students to receive instant feedback, which is beneficial for the adult student because it reinforces successful instructional behaviors (Learning with Computers, 1991). Immediate feedback allows students to progress and

make adjustments in their learning while assisting students in developing skills in logic, problem solving, and following directions (Askov and Bixler, 1996).

Kulik and Kulik (1991) conducted research on the effectiveness of using computers to increase student achievement. They found the students in the CAI classes had higher exam scores than students who were taught by conventional methods with computer technology with the average student in a CAI class scoring in the 62nd percentile on achievement exams; while the average score for students in a traditional class was in the 50th percentile on the same exam. Li and Edmonds (2005) found that at-risk students with low literacy skills are hindered by their inability to comprehend written language at this level in a CAI environment. Having learners keep journals develops language and math skills together. Journal writing also helps them verbalize their thought processes, and enables them to express emotional reactions and feelings about mathematics (Halliday and Marr, 1995). Self-paced, self-sufficient computerized technology used by students in remedial programs may change the role of the instructor to that of a facilitator, but the computer does not replace the instructor. The role of the instructor is critical in the management of the educational systems, especially in introducing students to computer use (sometimes for the first time), and monitoring and providing timely feedback on the student's progress (Keup, 2001).

Anderson et al, (2000), reviewed theoretically and empirically well-grounded research on how technology can promote student learning. They concluded that instructional programs that included technology show a positive impact on student achievement, resulting in higher test scores. The key findings from these studies include the following:

- Classrooms in which computers were used to support instruction usually showed gains in student achievement as measured by standardized achievement tests.
- The effectiveness of different applications of CAI varied by the content area and the skill being taught. In general, applications were more positive if delivered in a content area with a defined structure, such as mathematics (Valdez, McNabb, Foertsch, Anderson, Hawkes, & Raack, 2000).

CAI in classrooms provides opportunities for hands on experience. Not only do they learn computer skills, adult learners also learn academics via the computer and are able to develop and improve higher order thinking skills (Askov and Bixler, 1996). Access seems to have had a positive effect on students' perception of how much they learned. The more access and use they had of the CAI whether at school or at home, the more their understanding of math concepts increased (Li, and Edmonds, 2005).

Finally, researchers have identified certain students, faculty, and institutional features that facilitate the implementation and success of these computer-assisted remedial education systems. Perry and Ford (1994) state that for CAI to be successful the program needs mature, independent students, a sophisticated computer system and a computer lab. Cornell, et al. (1996) found a relevant and holistic curriculum with clear learning objectives to be integral to success. Anadam, (1994) lists such features as faculty involvement, an institutional commitment to technology, faculty development programs, and realistic expectations and assessment procedures. Traynor (2003) states that a CAI program that incorporates one or more of the following five mechanisms would have a significantly positive effect on student learning regardless of program type: These mechanisms include:

1. Personalizing information
2. Animating objects on the screen
3. Providing practice activities that incorporate challenges and curiosity
4. Providing a fantasy context
5. Providing a learner with choice over his/her learning

The technology industry has struggled for a place in the traditional education system. The true question regarding technology use in higher education curriculum is not should computers be used in education but “how” (Rapp and Gittinger, 1993,). Using technology is one of the elements recommended for developmental mathematics programs (McCabe and Day, 1998; Darken, 1995). However, in a study conducted by House (2002), there was a significant negative relationship between the use of computers and mathematics achievement. House found that there was a tendency for students to earn lower mathematics test scores when teachers more frequently use computers to demonstrate mathematics ideas during classroom lessons. In an effort to increase financial efficiency and learning effectiveness, colleges have investigated the use of technology and computer-aided instruction in remedial education (Wilson, 1992; McMillan, Parke & Lanning, 1997).

The range of technology that could be used in schools is increasing yearly the cost of adopting new technologies is an inhibiting factor to its use (Hancock and Betts, 1994). However, technology may be more productive when it is used in combination with cooperative learning. Researchers agree that using cooperative learning in combination with CAI is more productive than using CAI individually (Dyer, 1994; Crook, 1994; Keup, 2001; Johnson and Johnson, 2004; Marshall, 1995). The spontaneous cooperation

often reported around technology casts doubts on the individual assumptions made by the designers of hardware and software, and points toward the use of cooperative learning in technology supported instruction (Dyer, 1994). Using computer-aided instruction along with cooperative learning is a critical component to computer-assisted remedial education. Student to student communication was either a built in component to the computer system or was strongly encouraged in remedial/developmental programs (Keup, 2001).

Cooperative Learning and Technology

Before the 1990s, most of the research on computer-supported learning was based on the single learner assumption. The individual assumption is that instruction should be tailored to each student's personal aptitude, learning style, personality characteristics, motivation, and needs. Computers were viewed as an important tool for individualizing learning experiences, especially for CAI programs based on programmed learning, but also for learning experiences derived from constructivist principles (Crook, 1994). The failure of schools to adopt available instructional technologies and to maintain let alone continuously improve their use may be due in part to two barriers: a) the individual assumption underlying most hardware and software development and b) the failure to utilize cooperative learning as an inherent part of using instructional technologies (Johnson, & Johnson, 2004).

Given the limitations of the individual assumption, and its shortcomings, technology may be more productively used when it is used in combination with cooperative learning. According to Johnson and Johnson (2004), to enhance learning, technology must promote cooperation among students and create a shared experience. Marshall (1995) points out

that by working together students produce trust, integrity and results by building true consensus, ownership and alignment. The capabilities of computers can be used as mediating tools that help students to focus their attention on mutually shared objects (Crook, 1996). Interacting around computers stresses the use of computers as tools to facilitate communication between students (Crook, 1996).

Adding technology to a lesson inherently increases the lesson's complexity. When students participate in technology-supported instruction, they have the dual tasks of (a) learning how to use the technology and (b) mastering the information, skills, procedures, and processes being presented within the technology (Johnson and Johnson, 2004). Furthermore, when cooperative learning groups are used, students have the additional task of learning teamwork, procedures, and skills. The initial use of technology-supported cooperative learning may take more time, but once students and teachers master the new systems, the results will be worth the effort (Johnson and Johnson, 2004).

Cooperation at the computer promoted greater motivation to persist on problem-solving tasks. Students in the cooperative condition were more successful in operating computer programs (Johnson and Johnson, 2004). In terms of oral participation, students in the cooperative condition, compared with students in the competitive and individualistic conditions made fewer statements to the teacher and more to each other, made more task-oriented statements and fewer social statements, and generally engaged in more positive, task-oriented interaction with each other (Johnson, Johnson and Stanne, 1989; Johnson et al., 1990; Johnson, Johnson and Stanne 1985, 1986; Johnson, Johnson, Stanne, Smizak, and Avon, 1987; Johnson, Johnson, and Richards, 1986).

Dyer (1993) compared structured cooperative pairs, unstructured cooperative pairs, and individuals working alone to solve computer assisted math problem solving lessons. He found structured cooperative pairs communicated more frequently and used the computer more efficiently and skillfully than did the unstructured cooperative pairs or the students in the individualistic condition. Cooperative learning established a mutually supportive learning environment among group members in which both cognitive difficulties and navigational disorientation were overcome in using the computer to complete a symbolic reasoning task. Hooper et al. (1993) discovered that students studying alone had greater difficulty reading and understanding lesson directions, used the help option more often, and required more attempts to master embedded quizzes than did students in cooperative learning groups.

Technology supported cooperative learning tends to increase the effectiveness of learner control. When students work alone, in isolation from their peers, they tend not to control the learning situation productively, making ineffective instructional decisions and leaving instruction prematurely (Carrier, 1984; Hannafin, 1984; Milheim & Martin, 1991; Steinberg, 1977, 1989). Cooperative pairs spent longer times inspecting information on the computer screen as they discussed which level of feedback they needed and the answers to practice items. Students in the learner controlled/cooperative learning condition selected additional options during the lesson, and spent more time interacting with the tutorial, than did students in the learner controlled/individual learning condition (McDonald, 1993).

Crooks, Klein, Leader, & Savenye (1998) conducted a study of 195 undergraduate students majoring in education and enrolled in an educational psychology course at a

southwestern university. The participants were randomly assigned to either the cooperative-learning or individual-learning condition, using CBI. It was found that variations in instructional method and learner-control mode had no effect on student performance on the post-test, which assessed learning of the information presented in the CBI program.

In the same study, Crooks, Klein, Leader and Savenye found students working in cooperative dyads and those working alone did not differ in their attitudes toward the computer lessons. Differences were found, however, in their attitudes toward the instructional method. Compared with students who worked alone, the students in the cooperative dyads expressed a significantly greater preference for working with another student to learn content presented by a computer in the future.

Brinkerhoff, Brush, and Klein (2005) showed similar results. Participants were 159 undergraduate students enrolled in a computer literacy course at a large university in the southwestern United States. There were four treatment groups in this study: Individual with Advisement, Individual with no Advisement, Informal Cooperative Dyad with Advisement, and Informal Cooperative Dyad with no Advisement. The results of the study indicate that participants provided with advisement performed significantly better on the post-test than those receiving no advisement. Although the results indicate that those receiving advisement did show higher levels of achievement, the overall achievement level for all participants was low. According to Brinkerhoff, Brush and Klein (2005), while advisement had a significant effect on post-test achievement, learning strategy did not. This may be due to the fact that the study represented the only time students engaged in cooperative learning during the entire class.

An inverse relationship was found to exist between the amount of technology used in a developmental course and the pass rate for that course. Instructors who reported using computers to provide the majority of classroom instruction had significantly greater failure rates than those who reported using computers only as a supplement to classroom instruction (Moylan, Bonham, Claxton, & Bliss, 1992).

Cooperative Learning

According to Johnson and Johnson (1999), there are four types of cooperative learning; formal cooperative learning groups, informal cooperative learning groups, cooperative base groups, and academic controversy. Formal cooperative learning groups last from one class period to several weeks. Informal cooperative learning groups are ad/hoc groups that last from a few minutes to one class period. Cooperative base groups are long term lasting at least a year, and academic controversy is where one student's ideas are different from another student, and the two students must work together to reach an agreement (Johnson and Johnson, 1999).

Johnson, Johnson, and Smith (1998) suggest that the foundation for small group cooperative learning structure is to maximize student's learning, and is the result of social interdependence theory, cognitive-developmental theory, and behavioral learning theory. Social interdependence theory states on the one hand that positive interdependence leads to promotive interaction as students within a cooperative learning group encourage and facilitate each group member's learning and output. Promotive interaction leads to increased efforts to achieve positive interpersonal relationships, and psychological health. On the other hand, negative cognitive developmental interdependence often results in dysfunctional interaction as group members impede and discourage each other's efforts

to perform (Johnson, Johnson, and Smith, 1998). Furthermore, there is less effort to achieve among group members, who are oppositional and have little or no interaction. These group members tend to have negative interpersonal relationships, and psychological maladjustment (Johnson and Johnson, 1999).

The cognitive developmental perspective is grounded in the work of Jean Piaget and Lev Vygotsky. Piagetian perspectives suggest that when individuals work together socio-cognitive conflict occurs and creates cognitive disequilibrium that stimulates perspective-taking ability and reasoning. Cooperative learning in the Piagetian tradition is aimed at accelerating a student's intellectual development by forcing him or her to reach consensus with other students who hold opposing views about the answer to the task. (Johnson & Johnson, 1999, p. 187). Vygotsky and related theorists claim that our distinctively human mental functions and accomplishments have their origins in our social relationships. Mental functioning is the internalized and transformed version of the accomplishments of a group. The behavioral-social perspective presupposes that cooperative efforts are fueled by extrinsic motivation to achieve group rewards (academic and nonacademic) (Johnson, Johnson and Holubec, 1998).

All three theories have inspired research on cooperation, the most fully developed, the most clearly related to practice, but the theory that inspired most of the research is social interdependence theory (Johnson and Johnson, 1999). There is another theory developed by Johnson, Johnson, and Smith (1998) which states that when students are confronted with opposing points of view, uncertainty or conceptual conflict results, which creates a re-conceptualization and an information search, which in turn results in a more refined and thoughtful conclusion.

Baer, 2003; Cooper, Robinson, and McKinney, 2002; DePree, 1998; Gokhale, 1995; Johnson, Johnson, and Smith, 1991; all conducted research which verified that students who worked in cooperative learning groups had higher achievement scores compared to students who worked alone. Small group instruction had a significant positive effect on course completion rates as compared to lecture instruction (DePree, 1998). Success also affects attrition rates: the higher the achievement of the students, the more committed they tend to be to completing college. It is important to use instructional methods that maximize student achievement (Johnson, Johnson and Smith, 1998).

Individually competitive goal structures give students individual goals and reward them by mean of a comparative or normative evaluation system. In an individually competitive structure a student can attain his or her goal only if other participants cannot attain their goals (Sherman, 1996). Many college faculties are required to grade on the curve (Johnson, Johnson and Smith, 1998). This norm-referenced approach to student evaluation requires students to compete with each other for grades, which has many consequences for academic life. Many professors seek to avoid the pitfalls of such competition by using an individualistic approach to instruction. Each student's efforts are evaluated on a criterion-referenced basis (Johnson, Johnson and Smith, 1998). Yet students are expected to work individually to accomplish learning goals unrelated to those of other students. Working cooperatively, students can work together to accomplish shared learning goals. Each student achieves his or her learning goal if and only if the other group members achieve theirs (Johnson, Johnson, and Smith, 1998).

Johnson, Johnson, and Smith, (1991); Cooper, Robinson, and McKinney, (2002) suggests that cooperative learning does produce higher achievement, positive

relationships among students, and healthier adjustments than individual experiences; however, the effects do not automatically appear when students are placed in groups. For cooperative learning to occur, the professor must carefully structure learning groups. In a study by Baer (2003) which compared the impact of heterogeneous and homogenous cooperative learning groups on achievement, he found that when using cooperative learning, homogenous grouping in an undergraduate course resulted in higher achievements than heterogeneous grouping.

Heterogeneous teams which reflect varied learning abilities, ethnic and linguistic diversity, and mixed gender are advocated by Kagan (1992) and Johnson, Johnson, & Smith (1991). Most employers value cooperation and teamwork, heterogeneous teams provide opportunities to prepare for or to reinforce practices that will be needed in the workplace (Millis & Cottell Jr., 1998). Another consideration when forming cooperative learning groups is the size of each group.

Although cooperative learning groups range in size from two to four students, the basic rule of thumb is the smaller the better, however, there is no ideal size for a cooperative learning group (Johnson & Johnson, 1999). A common mistake is to have students work in groups of four, five, and six members before the students have the skills to do so competently (Johnson & Johnson, 1999; Leikin & Zaslavsky, 1999). What determines group productivity is not who its members are, but rather how will the members work together (Johnson & Johnson, 1999). Once groups are selected it is important that certain components of cooperative learning are in place. Two key components of cooperative learning are positive interdependence and individual accountability.

Positive interdependence empowers students who might otherwise lose their voices in traditional classrooms where the teacher and more vocal students tend to dominate classroom discussions. Everyone in a well-conducted cooperative learning classroom has an opportunity for equal participation and equal validation (Millis & Cottell, Jr., 1998). The second key component is individual accountability. In cooperative learning, students are responsible for their own academic achievements. Their final course grades will be based on their own efforts uncompromised and uncomplicated by the achievements of others (Millis & Cottell, Jr., 1998).

Gokhale, (1995), investigated the effectiveness of individual learning versus collaborative learning in enhancing drill and practice skills and critical thinking skills. Gokhale discovered that students who participated in cooperative learning performed significantly better on the critical thinking test than students who studied individually. It was also revealed that both groups did equally well on the drill and practice test. Webb's (1983, 1991) research indicates that student achievement is directly correlated to the level of elaboration of help that students provide to other group members.

Cuseo (1996) contends cooperative learning discourages passivity among students by allowing them to be in charge of their own learning, encouraging them to become actively involved with the subject matter and with each other. In a study conducted by Potthast (1999) students working in cooperative learning groups seemed to promote greater communication with the instructor as well as with other classmates. She also found the group employing cooperative learning techniques scored higher on tests. Cooperative learning procedures may provide a remedy for student passivity by allowing

all students to become more involved with the course material, and with each other as they actively work together in small groups (Cuseo, 1996).

Cooperative learning can be regarded as a more structured, more focused form of collaborative learning. Cuseo (1992) places cooperative learning as a subtype under collaborative learning. He also finds cooperative learning to be “the most operationally well defined and procedurally structured form of collaboration among students (p.3).

Conclusion

Teacher-centered instructional methods, such as lectures and instructor led class discussions appear not to be the most effective teaching strategy. The research indicates that at the very least the occasional use of small group learning experiences can be expected to benefit a variety of critical educational outcomes at the collegiate level.

The Accounting Education Change Commission (1990) has told faculty of higher education they need a new approach to teaching. The Commission endorses active learning through complex problem solving, experiential approaches, group work, and innovative uses of technology.

The Art Institute of Pittsburgh

The research will focus on students from The Art Institute of Pittsburgh; therefore, a brief history of how The Art Institute of Pittsburgh began offering academic degrees follows. More of the history of The Art Institute of Pittsburgh can be found in (Appendix A). Prior to 1995 The Art Institute of Pittsburgh issued technology degrees to its graduates. It wasn't until 1997 that The Art Institute of Pittsburgh began to offer courses which allowed them to issue academic degrees. There were primarily four factors

influencing the decision to apply for the rights to grant academic associates and bachelor's degrees.

1. The media arts and animation program offered the Associates in Specialized Technology. In 1993 students in the Media Arts and Animation programs could leave the school with a diploma and find jobs in the field. By 1996, the market became saturated, but students continued to enter this program. They were enrolling in the program with little or no drawing skills, and teaching those skills required more than two years of training.
2. The Interior Design Program needed to be accredited by the Foundation of Interior Design and Education Research (FIDER). The Art Institute program was a 27-month program: the accreditation by the Foundation of Interior Design and Education Research typically required a four year program leading to a bachelor degree.
3. The Industrial Design Program was added which is typically a four to five year program and the skills needed for this field could not be taught in two years.
4. The credits earned by the students of The Art Institute of Pittsburgh would not easily transfer to other accredited schools.

In order to receive accreditation and the right to grant academic associates and academic bachelor degrees, The Art Institute of Pittsburgh had to include in their programs general education classes. The general education programs began January, 1997, and as a result of students entering the school who were not prepared to successfully complete college level mathematics or English, The Art Institute of

Pittsburgh discovered the need to offer developmental classes to assist those students who were talented in art, but lacking in language and mathematical skills.

The Art Institute of Pittsburgh uses computers in each of their developmental mathematics classes to supplement the lecture portion of the class. Many colleges and proprietary schools have investigated the use of computer-aided instruction in remedial education (Wilson, 1992; McMillan, Parke & Lanning, 1997), and found the results have been positive.

The Art Institute of Pittsburgh currently uses a mathematics computer program called Aleks, (Assessment and Learning in Knowledge Spaces). ALEKS is based on the theory of Knowledge Space, which analyzes how knowledge is acquired. The theory has been supported in the United States since 1983 by various grants, mostly from the National Science Foundation. To date, there is no research to the claims made by ALEKS.

Theory of Knowledge Space

According to Falmagne, Cosyn, Doignon, Thiery, (ND) the theory Knowledge Space represents a sharp departure from other approaches to the assessment of knowledge. No attempt is made to obtain a numerical representation. They start from the concept of a possibly large, but essentially discrete set of units of knowledge. For example, with Elementary Algebra one unit might be a particular type of algebra problem, with two key concepts: knowledge state, a particular set of problems that an individual is capable of solving correctly, and the knowledge structure, which is a distinguished collection of knowledge states.

Knowledge Space Theory suggests some algebra problems may be solvable only if that student has already mastered some other problems. Some concepts are always taught

in a particular order, even though there may be no logical or pedagogical reason to do so. This precedence relation may be used to design an efficient assessment mechanism.

As an example, six types of problems in Elementary Algebra are used: (1) word problems on proportions (2) plotting a point in the coordinate plane (3) multiplication of monomials (4) greatest common factor of two monomials (5) graphing the line through a given point with a given slope (6) writing the equation of the line through a given point and perpendicular to a given line. A respondent can master problem a, but that does not imply knowing anything else; however, if he or she knows problem e, then problems a, b, and c must have been mastered forming a knowledge state. The knowledge structure allows several learning paths. The full mastery state of abcdef can be achieved by first mastering problem a, then successively the other problems in order $b \rightarrow c \rightarrow d \rightarrow e \rightarrow f$.

However, according to the authors, there are other ways to learn.

In the case of Elementary Algebra, there are approximately 60,000 knowledge states and billions of learning paths (Falmagne, Cosyn, Doignon, Thiery, ND). In a knowledge state there are inner and outer fringes as well. The two fringes can be used as the main building blocks of the navigation tool of the system, with the outer fringes directing the progress, and the inner fringes monitoring temporary retreats, and making them profitable. The fringes are used to summarize the results of an assessment. A knowledge state is a list of all the problems mastered by a student at the time of an assessment. The result of an assessment can be given in two lists, one for the inner fringe (what the student can do, which is the most sophisticated problems in the student's state, and one for the outer fringe (what the student is ready to learn).

The task of the assessment is to uncover, by efficient questioning, the knowledge state of a particular student under examination. The situation is similar to adaptive testing like the computerized forms of the S.A.T. with the critical difference that the outcome of the assessment in this theory is a knowledge state, rather than a numerical estimate of a student's competence in the topic. At the beginning of the assessment each of the knowledge states is assigned a certain a priori likelihood, which may depend upon the school year of the student if it is known, or some other information. The sum of these priori likelihoods is equal to 1. They play no role in the final result of the assessment but may be helpful in shortening it. The first problem is chosen to be maximally informative. This is interpreted to mean that, on the basis of the current likelihoods of the states, the student has about a 50% chance of knowing how to solve the first problem. If several problem types are equally informative (which may be the case at the beginning of an assessment) one of them is chosen at random. The student is then asked to solve an instance of that problem, also picked randomly. The student's answer is then checked by the system, and the likelihood of all the states are modified according to the following updating rule. If the student gave a correct answer to problem 1, the likelihoods of all the states containing problem 1 are increased and, correspondingly, the likelihoods of all the states not containing problem 1 are decreased (so that the overall likelihood, summed over all the states, remains equal to 1). A wrong response given by the student has the opposite effect: the likelihoods of all the states not containing problem 1 are increased, and that of the remaining states decreased. If a student does not know how to solve a problem, he or she can choose "I don't know" instead of guessing. Not guessing results in a substantial increase in the likelihood of the states not containing problem 1, thereby

decreasing the total number of questions required to uncover the student's state. Problem 2 is then chosen by a mechanism identical to that used for problem 1, and the likelihood values are increased or decreased according to the student's answer using the same updating rule.

The assessment procedure stops when two criteria are fulfilled: (1) the entropy of the likelihood distribution, which measures the uncertainty of the assessment system regarding the student's state, reaches a critical low level, and (2) there is no longer any useful questions to be asked (all the problems have either a very high or a very low probability of being responded to correctly). At that moment, a few likely states remain and the system selects the most likely one among them. Because of the stochastic nature of the assessment procedure, the final state may very well contain a problem to which the student gave a wrong response. Such a response is thus regarded as due to a careless error. On the other hand, because all the problems have open-ended responses (no multiple choice), with a large number of possible solutions, the probability of lucky guesses is insignificant.

ALEKS

ALEKS, a relatively new mathematics computer program, was developed at the University of California by a team of software engineers and cognitive scientists. The assessment procedure described above is the core engine of the automated mathematics tutor known as ALEKS. At the core of ALEKS is an artificial intelligence engine, which incorporates the theory of knowledge space, which analyzes how knowledge is acquired. The creators of ALEKS claim it can search an enormous knowledge structure quickly and efficiently and can accurately assess the exact knowledge state of any student in any

mathematics subject area. ALEKS employs technology that interacts with each student individually, identifying knowledge gaps and adapting its explanations and questions to the student's particular needs. The results of the assessment are displayed in a multi-colored pie chart which indicates the concepts the student needs to master. ALEKS then creates practice problems for the student to work on in each of the areas in which the student has a weakness. ALEKS provides immediate feedback and suggestions. ALEKS also has a dictionary which students may use to define mathematical terms that may be unfamiliar to them. When the student answers the appropriate number of problems correctly, ALEKS will move to a new concept. The next time the student logs onto ALEKS, he or she must answer problems from the previous concept to determine whether or not he or she has mastered the problems in that specific area. If the student is unable to correctly answer the problems, the concept is added back into the pie. ALEKS continuously updates its cognitive map of the student's knowledge.

Accuplacer

The purpose of Accuplacer tests is to determine which course placements are appropriate for students and whether or not remedial work is needed (College Entrance Examination Board, 2004).

Accuplacer tests can also be used to monitor student course progress and to suggest whether remediation is still needed or if a change in course assignment is recommended (College Entrance Examination Board, 2004).

The Accuplacer mathematics tests are computerized adaptive varying test questions and the questions themselves from student to student. The next question administered to an examinee is automatically chosen to yield the most information about the examinee

based on the skill level indicated by answers to all prior questions. Accuplacer tailors the test to each examinee, and initially administers an item of middle difficulty to each student. The questions are randomly selected from one of approximately five very similar items. If the student answers incorrectly, it branches to a randomly chosen one of three items that are easier. If the student answers correctly, it branches to a randomly chosen one of three more difficult items. Items presented stay very easy or very difficult until there is at least one right or wrong answer. At that time item selection aims for maximum information but is subject to constraints that provide for content balance. The students are then placed into classes as a result of the scores they achieve on the placement test (College Entrance Examination Board, 2004).

Scores for the tests are reported on a 120- point scale and represent an estimate of the score students could expect to receive if they had taken a test of 120 questions. Scores are reported as whole numbers. Percentile Ranks indicates student performance in relation to a normative sample of test takers. The normative population for the Accuplacer test was composed of college entry-level students at both two-and-four year colleges (College Entrance Examination Board, 2004).

Statement of the Problem

The reason this study is being conducted is to determine if mathematics achievement scores will increase for the group who works in cooperative learning groups using computer assisted instruction compared to participants working alone using computer assisted instruction. Also, the study is to designed to investigate whether students' attitude toward cooperative learning will increase positively after working in cooperative learning groups using CAI compared to the group who works alone using CAI. Finally,

this study will attempt to find if students' confidence in the subject matter will increase as a result of working in cooperative learning groups using CAI versus participants working alone using CAI.

CHAPTER 3

METHODOLOGY

The study will attempt to answer the following questions:

- Will there be a difference in mathematics achievement scores between students ages 18 to 30 years who use CAI in cooperative learning groups and students who use CAI individually?
- Will there be a difference in students' attitudes towards mathematics between students working in cooperative learning groups using CAI and students working individually using CAI?
- Will there be a difference in attitudes towards cooperative learning between students working in cooperative learning groups versus students working individually using CAI ?

This study was implemented at the Art Institute of Pittsburgh. The study was conducted to determine if there would be a difference in mathematics achievement scores between students working in cooperative learning groups using CAI and students working alone using CAI. The mathematics achievement scores were determined using a pre-post test. The Accuplacer Placement test was used as the pre-test and the post-test. The use of the pre-test gave the beginning score for each student and to determine whether there were any significant pre-existing differences between them. The study was also designed to collect information about attitudes towards cooperative learning, and students' confidence in the subject matter, by using the Fenneman-Sherman mathematics attitude scales. The survey was completed by participants at the beginning of the study

and at the end of the study. Students were placed in each section of basic mathematics (MTH099) classes through course registration rather than random selection, therefore the sample being used is a sample of convenience. Prior to registering for classes, students must take the Accuplacer pre-test, which determines the course students are registered for. The class schedule for new students are made by the academic advisors, therefore, new students do not make their own schedules. Furthermore, there is a possibility that students who are in MTH099 had been enrolled in MTH099 before. Students who were in MTH099 previously would have taken the Accuplacer test a second time. If students do not successfully complete the coursework required for MTH099 they must retake the class regardless of their score on the Accuplacer post-test. The fact he or she repeated the class would explain why there are scores higher than 65 on the descriptive statistics. A review of the scores revealed only one student had a score higher than 65 for the pre-test. Logistical issues created barriers to the random assignment of students; furthermore, ethical issues exist because students have paid for their education and the sample participants were presented with different instructional methods, namely working in cooperative groups using CAI or working alone using CAI. An independent samples t-test was conducted to compare pre-test scores for students working individually using CAI and students working in cooperative learning groups. Using 95% confidence level, and a p-score of .05, there was no significant difference in scores for students working individually ($M=47.45$, $SD=4.21$) and for students in cooperative learning groups ($M=43.89$, $SD = 2.17$). The students working alone using CAI represented the control group while students working in cooperative learning groups reflected the experimental group.

Class size was another consideration at The Art Institute of Pittsburgh. Developmental classes have a maximum of 19 students because of the availability of computers. This study required a sample size of 15 students in the cooperative learning group and 15 students in the individual learning group. The developmental mathematics instructors at The Art Institute of Pittsburgh normally teach five classes per quarter. This means during a slow quarter there may only be five sections of MTH099, or a maximum of 76 students who would be involved in the study. Two classes were assigned to the cooperative learning groups using CAI and two classes were assigned to work individually using computer assisted instruction. The fifth class was not part of the study. The exclusion of the fifth class was due in large part to the logistics of the room setup.

In a typical quarter, instructors can expect to lose two, three or more students per class for a variety of reasons, but this too would affect the study and the number of participants, which could affect the length of the study. If there are not enough students to complete the study initially, the study would have to be conducted the following quarter as well.

Instruments

To conduct the research, participants were required to complete an attitude survey towards mathematics and cooperative learning. The attitude survey was adapted from the Fennema Sherman Mathematical Attitude Survey. The Fennema-Sherman scale was originally developed for research investigating gender-differences in mathematics achievement among high school students (Mulhern & Rae, 1998). The original instrument consisted of nine scales, each with 12 items. The nine scales include: confidence in learning mathematics, perception of teacher's attitudes toward one as a

learner of mathematics, usefulness of mathematics, perception of mother's attitudes toward one as a learner of mathematics, attitude toward success in mathematics, effectiveness motivation in mathematics, mathematics anxiety, perception of father's attitudes toward one as a learner of mathematics and mathematics as a male domain (Broadbrooks, Elmore, Pedersen, & Bleyer1981).

The researcher adapted the Fennema-Sherman attitude scale by changing the wording of the mathematics attitude scale, and the confidence in learning mathematics scale to eliminate gender bias and to make each of the statements more precise. For example; instead of I can learn math, the words were changed to read I can learn Algebra.

The male domain scale was eliminated completely. The researcher created the cooperative learning portion of the survey, following the same format as the Fennema-Sherman scale. The survey consisted of 34 questions; Attitude towards mathematics, student's perception of teacher's attitudes toward one as a learner of mathematics, and attitudes toward cooperative learning.

Students' confidence about mathematics and students' attitudes toward cooperative learning scales contained 12 questions, six questions were positive attitudes and six questions were negative attitudes. The teacher's attitudes toward one as a learner contained 10 questions, five questions were positive attitudes and 5 were negative attitudes. The draft of the survey was examined by members in a graduate level seminar on program design and was rewritten according to suggestions provided by the members and instructor of the seminar.

The survey contained two parts. The first part contains demographic questions of gender, age, quarter student is enrolled, program of study and the degree program in

which the student was enrolled. The second part of the survey asked questions concerning their attitude toward mathematics, students' perception of previous teachers' attitudes, and student's attitudes concerning cooperative learning.

The survey used a Likert Scale, which the participants circled their answer 1 2 3 4 5. Positive item receives the score based on points. 1=1 2=2 3=3 4=4 5=5. The negative items were reversed 1=5 2=4 3=3 4=2 5=1. The survey took approximately 30 minutes to complete (Appendix B).

Melancon, Thompson, & Becnel (1994) investigated the factorial validity of the Fennema-Sherman scales, using a sample of 174 elementary school teachers. Melancon et al. obtained results that were generally favorable in regard to the factorial validity of the scores from the Fennema-Sherman Attitude Scales. Most of the correlations between the Fennema-Sherman Attitude Scales factor scores and scores on a social desirability measure were close to zero, indicating that scores on the scales had relatively good divergent validity. Mulhern and Rae (1998) provide further evidence regarding the factorial validity of the Fennema-Sherman Scale. They wanted to determine whether a shortened version of the Fennema-Sherman Attitudes Scale could be developed and still maintain validity and reliability. The results from both studies were similar.

Another study conducted by Broadbooks, Elmore, Pedersen, & Bleyer (1981) investigated the construct validity of the Fennema-Sherman Mathematics Attitudes Scales. The conclusion of the study was that for a sample of 1,541 junior high school students there was evidence to support the theoretical structure of the Fennema-Sherman Mathematics Attitudes Scales. Eight factors were interpreted to indicate that the scales measure eight different constructs within the domain of mathematics attitudes. These

results also provide evidence of the appropriateness of constructing multidimensional scales to measure attitudes toward mathematics.

A third study explored the measurement validity issue and was conducted by Thompson, Melancon, & Becnel (1993). In this study, factor analysis was the major analytic tool used to evaluate score validity. The result of the factor structure analysis was generally favorable with regards to the validity of scores from the Fennema-Sherman Scales. The results in the present study were reasonably supportive of a conclusion that scores on the measure were reasonably valid.

Accuplacer

The Accuplacer test was found in Mental Measurements Yearbook 13, which produced two reviews. According to the first review conducted by Martin A. Fischer, the reliability and validity of the Accuplacer test appeared to be very good. Both content and predictive validity were evaluated and appeared to be adequate. The conclusion of this review was that the Accuplacer appeared to be an excellent system for providing CPT evaluation and placement of students in appropriate courses. Results appeared reliable and can be evaluated and reported in a variety of ways.

The second review was conducted by Steven V. Owen, Reliability estimates of cut scores across the various tests range from .91 to .96. The content validation process involved panels of experts who offered advice about item content and wording.

The College Board provides institutions with proficiency statements which provide information for understanding students' skill levels which can be used as a guide in placing students. They do not provide definitive rules on placing students into regular or

remedial courses. At The Art Institute of Pittsburgh, students whose score is 65 or lower are placed in basic mathematics (MTH099). This rule applies to all majors.

According to the guidelines established by the College Entrance Examination Board students with a score lower than 65 have minimal arithmetic skills. These students are able to perform simple operations with whole numbers and decimals. They are able to calculate an average if they are given the values, solve simple word problems, and identify data represented by simple graphs. The students will have already taken the Accuplacer pre-test which is the test that determined the mathematics level in which they were enrolled. At the end of the quarter, each student will then take the Accuplacer post-test. This post-test will be used to compare the differences in achievement between the pre-test and post-test. (Appendix C)

Participants

The participants in this study were 18 years of age or older. Of the 51 participants in the study 84.1% were between the ages of 18 and 25, 10.6% between ages 26 and 30, and 5.3% were over age 30. The table below shows the percentage of students enrolled in MTH099 including the quarter for which they are currently enrolled as well as the degree program.

There were approximately 76 students registered for 4 sections of MTH099. Of the 76 students registered for the four sections of MTH099, 65 students signed the consent forms to participate in the study. Of the 65 students who began the study 51 participants finished the study. Eight of the students failed by attendance, five students withdrew from the classes, and one student withdrew from the school. Two sections of MTH099 worked individually using CAI, and 2 sections of MTH099 worked in cooperative learning

groups using CAI. There were 24 participants in the individual classes which were comprised of 13 males and 11 females. In the cooperative learning groups there were 27 participants, 13 females and 14 males. All of the sections were taught by the researcher ensuring that the lecture portion of the class and the computer assisted instruction portion were equitable.

Implementation

In order to proceed with the study, the researcher met with the President of The Art Institute of Pittsburgh to explain the study and the purpose of doing the study at The Art Institute of Pittsburgh. After the meeting, a letter was given to the President of the school which explained the study and requested a written letter in return granting permission to conduct the study at the school. Once written permission from the President of The Art Institute of Pittsburgh was received, the researcher was able to progress with the study.

Pilot Study

A pilot study was conducted during the winter05 quarter at The Art Institute of Pittsburgh. There were four classes involved with the study. Two classes were assigned to work on the computers in cooperative learning groups and two classes were assigned to work individually on the computer. The cooperative learning groups met once a week for four hours and the classes assigned to work individually met twice a week for two hours each class session.

The pilot study was conducted exactly as the actual study was to be conducted. An instructor not connected in any way to the classes presented the proposed study to the four classes. She then distributed the permission letter to the students and read the letter while the students followed along. Students who were willing to participate in the pilot

study signed the permission letter and placed them in a large envelope. The instructor then gave the survey to each student to complete. Students were asked to place their student identification number on the top of the survey. As students completed the survey, they placed the survey in a large envelope that was provided. When all the surveys were placed in the envelope, the envelope was sealed by the instructor who facilitated this portion of the pilot study. Students were also given a check-list and asked to place a check mark in each box where the questionnaire item meets the criterion.

The checklist can be reviewed in Appendix D.

The envelopes containing the permission letters and the surveys were then given to a third person who went through the surveys writing down the student identification numbers, and assigning a new number to the survey. The identification numbers were then blackened out so the researcher could not identify any student who may or may not have signed a permission letter and completed the survey.

The pilot study was conducted for ten weeks, with two classes working individually on the computer and two classes working in cooperative learning groups. The cooperative learning groups also kept a notebook where they solved the mathematical problems compared the answer with their partner, before entering the answer in the computer. At the end of each class, participants in this group were given ten minutes to write a guided reflection on the experience. The questions were:

- What did you learn new during this session?
- What did you perceive to be a challenge?
- How did you resolve the problem? What steps did you take to solve the problem?

At the end of the ten weeks, students were again asked to fill out the survey. All procedures that were conducted at the beginning of the quarter were followed at the end of the quarter. The criterion sheet filled out by students after completing the survey revealed the survey met all of the criteria, making it a well developed instrument.

The Study

The study was conducted during the spring05 quarter. A decision was made prior to the first day of class which sections would be the cooperative learning groups and which class sections would be the group working individually. The researcher asked a third party who was not involved with the classes to assign each of the classes to a particular group. After the class assignments were determined, the researcher assigned the students participating in the cooperative learning groups to their particular group by using a technique known as random selection and is recommended by Johnson and Johnson (1999). A number was assigned to each student on the class list 1, 2,3,4,5,6,7,8, or 9 depending on the class size. After assigning the numbers the students who were assigned the number 1 became partners during the computer laboratory time. Each cooperative learning class had 8 or 9 groups which consisted of two people in each group. In the event of an uneven number of students, the person without a partner would not be included in the data if he or she belonged to the class that was working cooperatively.

Prior to beginning the research study, a staff person who had no connection to the classes or influence on the students' grades presented to each of the four classes chosen to participate in the study, the purpose of the study, and how it was intended to be conducted. This person then asked the students to read a letter which also explained the research study (Appendix E). If students were willing to participate in the study, they

were asked to sign and return the letter of consent (Appendix F). The staff person stressed to each of the classes that participation in this study was completely voluntary, and a decision to participate, or not to participate would in no way affect their experience in the course or their course grade. The researcher began the study during week two of the quarter at which time students took the attitude survey. The survey contained 36 questions, and required approximately 30 minutes for the students to complete. The students were asked to place their student ID number in the upper right hand corner of the survey. When the students finished answering the survey questions they were asked to place their survey in a large brown envelope. After all of the surveys had been completed and the last one placed in the envelope the instructor asked one of the students to seal the envelope. The surveys were then given to a third party who recorded the ID numbers and assigned a different number to the survey. The third party then used a black marker to cross out each student's identification number and replaced it with the number he or she was assigned. This prevented the researcher from identifying any of the students who may or may not be participating in the study. At the end of the quarter, students were asked to once again fill out the attitude towards mathematics and cooperative learning survey. The same procedure was used for the end of the quarter surveys as with the first survey. By following these procedures it was impossible to know who completed the surveys, or identify any of the students who may or may not have participated in the study.

Class Design

The developmental classes at The Art Institute of Pittsburgh are either two hours in length, meeting twice a week, or one four hour per week session. The two hour classes

worked on the computers during one class section, and the following class session was lecture. It cannot be determined whether the computers or the lecture would occur first until room assignments were made. The evening classes would have lecture and computers in one evening. During the lecture classes the instructor lectured on a new concept, and if time permitted, students worked on class activities which were designed to enhance students' understanding of the days lecture. At the beginning of the lecture class, a review of the homework was conducted where the instructor read the answers to the homework problems. This was followed by a question and answer session to answer any questions student may have had regarding their homework.

Immediately following the review of homework, the students took a quiz on the concept that was learned the previous week and practiced through their homework. The students completed the quiz working alone, but with the assistance of using their notes and the use of a calculator. Each student was required to take their own quiz, thus ensuring individual accountability. Students who worked in cooperative learning groups received an average grade consisting of the grade received from their individual quiz and the quiz grade of their partner. Students had 25 minutes to complete the quiz. After the quiz had been completed and collected, a new lecture, covering a new concept began. On the alternate day the students worked on the computers either alone or in their cooperative learning pairs. Students in the cooperative learning pairs alternated turns on the computer. Student A and B were responsible for writing the mathematical problem that was presented on the computer in a notebook and the steps the students used to solve the problem before the answer was submitted into the computer. Since each student had a notebook, both students wrote the problem in their notebooks and solved the problem

individually, then compared their answers. At the end of each class student A and B was asked to write a short reflection paragraph on what they learned during the class, what they perceived to be a challenge for them, and how they resolved the problem. The students' final grade was determined through quizzes, homework completion, computer work, participation/attendance, midterm exam, and final exam.

The study continued through week 10 of the quarter. At this time students took the Accuplacer post-test. If any student was absent during week 10, the student was able to take the test during week 11, which was also the final week of the quarter. The students took a final exam covering all the material the students learned during the previous 10 weeks. This exam was prepared by the instructor to ensure all of the material was covered. Students were once again asked to complete the attitude survey. This was the same survey the students completed at the beginning of the quarter, and was used to compare responses to determine if their attitude towards mathematics or cooperative learning had changed as a result of their experience in the study. The result of the survey was not discussed with any of the students, since the researcher did not look at the surveys until the end of the quarter.

ANOVA verified there was not a statistically significant difference between the cooperative learning group and the group working individually, making the use of ANCOVA unnecessary. The results of the pre-post test were analyzed using descriptive statistics, Independent Samples t-test, and Paired Samples t-test. Also, descriptive statistics for the attitude survey for the individual group and the cooperative learning group was used followed by Paired Samples t-test and Independent Samples t-test.

The instructor acted as a facilitator for the cooperative learning groups and the students who worked alone on the computer to guide them if they had difficulties moving ahead with a problem. The instructor took precautions to only assist the student (s) if it was impossible for the student (s) to move ahead successfully on his or her own.

The purpose of this study was to determine if there was a difference in mathematics achievement scores between groups using cooperative learning methods using computer assisted instruction and those students working individually using CAI.

CHAPTER 4

RESULTS

Introduction

Learning mathematics is a difficult process for many students of all ages. It is well known that many students enter college either un-prepared or under-prepared to successfully complete college mathematic courses, so students are enrolled in developmental mathematics classes, which can range from basic mathematics (arithmetic) to advanced algebra (Anderson & McClenney, 2001; Gardner, 1994; McCabe & Day, 1998). Teaching and learning mathematics has changed very little since the beginning of formalized education. Instructors typically lecture and show examples of particular mathematic problems to be solved, and then assign problems for students to solve on their own after class. This method of teaching is especially true in higher education, where instructors expect students to work independently of one another. With the introduction of computers into schools, teachers have the option of scheduling time in the computer laboratories for drill and practice of mathematics, a method known as computer assisted instruction. While the use of computers is widespread, students are still expected to work alone in a competitive atmosphere, where a student can attain his or her goal only if other participants cannot attain their goals (Sherman, 1996). An area that has not been explored is whether mathematic achievement scores will increase if students in higher education use cooperative learning and computer assisted instruction.

For that reason, the purpose of this study was to determine whether using cooperative learning and computer assisted instruction would increase mathematics achievement scores, compared to working alone using computer assisted instruction in a

developmental mathematics classroom. The sample population consisted of 51 students enrolled in four sections of MTH099 or basic mathematics at a college located in Pittsburgh, PA. A pre- and post-test was given to students to determine if there was a significant difference in mathematics achievement scores between participants working in cooperative learning groups using CAI, and students working alone using the same computer program during a 10 week period. Also a pre- and post-survey was given to all participants to explore a change in students' attitude toward cooperative learning and mathematics.

This chapter describes the data collected and the results of the statistical analyses of the study. First the statistical methodology is reviewed for mathematics achievement scores. Next, descriptive statistics for the individual group and the cooperative learning group are discussed, which are followed by an Independent Samples T-test. This is followed by the results of the ANOVA testing, and finally the results of a Paired Samples T-test. Additionally, descriptive statistics for the attitude survey for the individual group and the cooperative learning, which are followed by the Paired Samples T-test.

Findings

Statistical Methods

Analyses of variance (ANOVAs) were performed to determine if there was a significant increase in mathematic achievement scores for students working in cooperative learning groups using CAI compared to the participants who worked alone using the same program in a basic mathematics (arithmetic) course during a 10 week period. All students were given a pre-test prior to the start of the quarter. The results of the pre-test were then compared to the results acquired with a post-test at the conclusion

of the study. Participants were also asked to complete a survey at the beginning of the study and the same survey at the end of the study in an attempt to determine if the participants' attitudes had changed from the launch of the study to the end of the study.

Descriptive Analysis

Data collection resulted in a total sample of 51 participants including 27 participants in the cooperative learning group, and 24 participants in the individual group. Out of a total of 65 possible participants, 1 individual opted out of the study, and 24 individuals had to be dropped for a variety of reasons including: dropping out of school, failing the class due to missing too many classroom hours, (attendance failures), or illness which required the students to drop the class. Participants who remained in any of the four sections of MTH099 taught by the researcher were presented the material at the same pace, regardless of whether he or she chose to be a participant in the research study or not. Only those students who signed consent forms had their data included in the present study.

Descriptive statistics for the Accuplacer pre- and post-test for the individual group (students who worked alone using computer assisted instruction) and the cooperative learning group are presented in Table 1. These descriptive statistics illustrate for the individual group on the pre-test a range from the lowest score (21) to the highest score (106). The post-test scores for those working individually, range from the lowest score (24) to the highest score (71). Note, that while some students' scores increased, there was also a decrease in performance of some students from the beginning of the study.

Descriptive statistics for the cooperative learning group show a range from the lowest score (23) to the highest score (68) on the pre-test. The post-test scores range from the

low (39) to the high (99). These scores clearly illustrate an increase in scores for the cooperative learning group. Overall, however, there was a rise in the achievement levels of both groups. Figure 1 is a pictorial graph demonstrating the pre-test scores for the individual group and the cooperative learning group on the Accuplacer Test. The graph shows that both groups received similar pre-test scores and does not need to be adjusted through the use of ANCOVA.

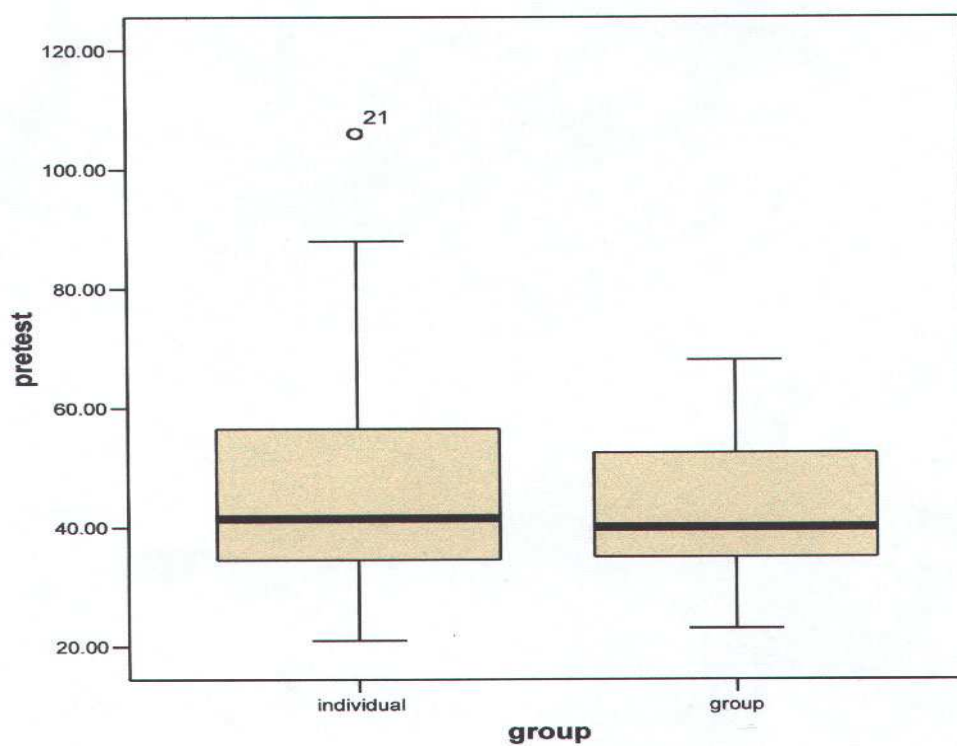
Table 1

Descriptive Statistics: Total Sample of Participants in the Cooperative Learning Group and Students working individually using Computer Assisted Instruction on Accuplacer Pre-Test and Post-Test.

Variable	N	Minimum	Maximum	Mean	SD
Pre-Test					
Individual	24	21	106	47.45	20.63
Group	27	23	68	43.89	11.51
Post-Test					
Individual	24	24	71	62.16	18.50
Group	27	39	99	71.71	15.83

Figure 1

Pictorial Graph Representing the Individual Group, and the Cooperative Learning Group on the Accuplacer Pre-Test.

Figure 1 Pre-test

Independent Samples t-test

An Independent Samples Test was performed to determine if the hypothesis was true, or should be rejected. If the mathematics achievement scores are essentially the same on the post-test, then the hypothesis would be rejected. Table 2 shows the results for the Independent Samples Test for the pre-test and the post-test. It is important that there was no difference between the participants working alone using computer assisted instruction and those working in cooperative learning groups using computer assisted instruction on the pre-test, with groups showing a mean difference of 3.56; $p = .45$ (ns). There was however, a statistically significant difference between the post-test of the individual group and the cooperative learning group with a mean difference of -9.54; $p < .05$.

Table 2

Independent Samples Test: t-test for Equality of Means for the Accuplacer Pre-Test and Post-Test.

	t	df	Sig. (2-tailed)	Mean Difference
Pre-Test				
Equal Variances Assumed	.78	50	.43	3.56
Equal Variances Not Assumed	.75	34.80	.45	3.56
Post-Test				
Equal Variances Assumed	-2	50	.05	-9.54
Equal Variances Not Assumed	-1.98	45.62	.05	-9.54

Analysis of Variance

As indicated in Chapter 3, the original intent of the study was to compare the mathematic achievement scores between students working alone using computer assisted instruction, and students working in cooperative learning groups using computer assisted instruction through the use of (ANCOVA) to adjust for initial levels of mathematics achievement. However, after analyzing the data, no significant differences were observed among the groups even without controlling for initial achievement making the use of ANCOVA technique unnecessary. As a result, analyses of variance (ANOVAs) were used to analyze the data.

An analysis of variance (ANOVA) was calculated, and the F-ratio was used to determine if any significant differences existed among the two mathematics groups. Results of the ANOVA for both groups' pre- and post-test scores are presented in Table 3. The analysis of variance revealed that there was not a significant difference among the cooperative learning group and the individual group on the pre-test, $F(.61) p = .43$. Results show there was a significant increase in performance from the pre-test to the post-test scores of the participants in the cooperative learning group compared with the participants who worked alone. The results of the post-test among the cooperative learning group and the individual group yielded an $F(4.02); p = .05$. These results indicate that the cooperative learning group may be generally considered the most effective method of using computer assisted instruction. Figure 2 depicts a pictorial graph of the post-test for the cooperative learning group and the individual group. The graph shows there is clearly a difference in mathematics achievement scores with the cooperative learning group receiving much higher scores than the individual group.

Table 3

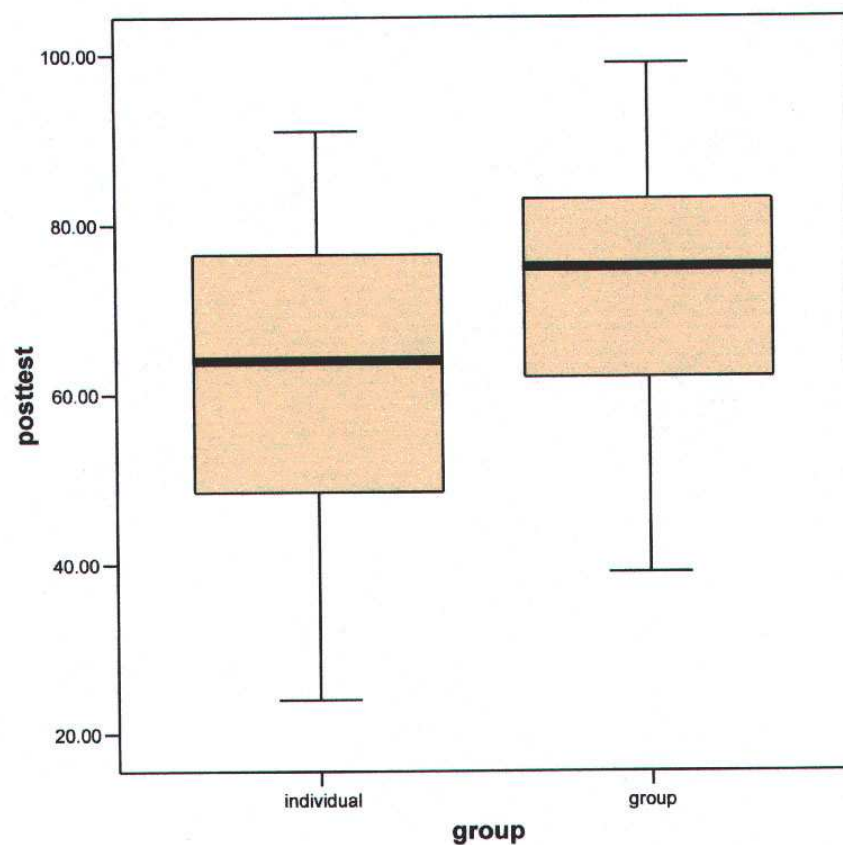
Analysis of Variance Results: Difference Between Pre- and Post-Test Scores for the Total Sample of Participants in Both Groups Including the Cooperative Learning Group and the Individual Group.

	Source	DF	SS	MS	F	Sig.
Pre-test	Between Groups	1	164.28	164.28	61	.43
	Within Groups	50	13378.63	267.57		
	Total	51	13542.92			
Post-test	Between Groups	1	1178.02	1178.02	4.02	*.05
	Within Groups	50	14651.04	293.02		
	Total	51	158.29			

Note. * = significant at .05

Figure 2

Pictorial Graph Representing the Cooperative Learning Group and the Individual Group on the Accuplacer Post-Test.

Figure 2 Post-test

Paired Samples t-test

To determine whether there was an increase of mathematic achievement scores within each of the two groups from the pre-test to the post-test, a paired samples t-test was performed. Table 4 shows there was a statistically significant increase for students working individually using computer assisted instruction. The pre- and post-test scores for students working individually, indicated a significant difference ($p=.00$) between the pre-test and post-test scores. The pre- and post-test score for the participants in the cooperative learning group indicated there was a significant difference ($p = .00$), between the pre-test and post-test scores.

Table 4

Paired Samples t-test: For Cooperative Learning Group and Individual Group on

Accuplacer Pre-Test and Post-Test.

	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-Tailed)
Individuals						
Pre-test-	47.45	20.63	4.21		23	
Post-test	62.16	18.50	3.77	.00	23	.00
Group						
Pre-test-	43.89	11.51	2.17		27	
Post-test	71.71	15.83	2.99	-10.65	27	.00

Additionally, an attitude survey was distributed to the participants for completion at the launch of the study, and the same survey was given at the conclusion of the study. The survey contained five demographic items, 12 Likert scale items under the heading of Student Confidence about the Subject Matter, 10 Likert scale items under the heading of Teachers Attitudes, and 12 Likert scale items with the heading of Students Attitudes Concerning Cooperative Learning. This survey was used to measure the confidence of students toward the subject matter, students' perception of previous mathematics teachers' attitudes, and cooperative learning. Table 5 shows the descriptive statistics for the survey. While there was an increase in the scores, which indicates that during the course of the study, some students' attitudes concerning their confidence in the subject matter increased and their attitude toward cooperative learning also increased. However, there was not a statistically significant difference between the pre-survey and post-survey in all three sections for the participants working individually, or for those working in cooperative learning groups.. Also, an Independent Samples t-test was conducted to determine differences between the cooperative learning group and those who worked alone. Table 6 represents the findings of the Independent Samples t-test. Furthermore, a Paired Samples t-test was calculated for each of the three sections of the survey that were asked of all participants at the beginning and at the end of the study. The results of the Paired Samples t-test for both groups are presented in Table 7.

Descriptive Statistics

Descriptive statistics for the attitude survey with the individual group (students who worked alone using computer assisted instruction), and the cooperative learning group are presented in table 5. These descriptive statistics are presented according to the three sections of the survey. Pre-attitude and Post- attitude refer to Student's Perception of Previous Teacher's Attitudes. Pre-confidence and post-confidence refer to Student's Confidence in the Subject Matter. Pre- cooperative and post-cooperative refer to the section titled Student's Attitude Toward Cooperative Learning. As stated in chapter 3, the survey used a Likert Scale using titles of Strongly Agree, and a score of (1); Somewhat Agree (2); Neutral (3); Somewhat Disagree (4); Strongly Disagree (5). All positive statements used the numbers 1, 2, 3, 4, 5. The negative statements were scored using the reverse. Strongly Agree (5); Somewhat Agree (4); Neutral (3); Somewhat Disagree (2); Strongly Disagree (1).

Table 5

Descriptive Statistics: Participants in the Cooperative Learning Group and the Individual Group.

Variable		N	Minimum	Maximum	Mean	SD
Individual	Pre-attitude	24	14	41	32.54	6.10
	Post-attitude	24	18	47	33.91	7.80
	Pre-confidence	24	16	51	30.66	9.33
	Post-confidence	24	13	52	34.20	9.65
	Pre-cooperative	24	22	59	39.70	10.50
	Post-cooperative	24	21	60	39.95	11.26
Group	Pre-attitude	27	14	47	33.03	8.70
	Post-attitude	27	21	50	34.37	8.60
	Pre-confidence	27	21	60	35.22	10.83
	Post-confidence	27	25	60	38.44	9.89
	Pre-cooperative	27	25	56	41.25	8.42
	Post-cooperative	27	21	58	45.55	8.21

Paired Samples t-test

To determine whether there was a difference in responses on the attitude survey within each of the two groups from the pre-survey to the post-survey, a paired samples t-test was performed. A paired samples t-test is used to test and re-test the same group and collect data from them at two different occasions. Table 6 shows there is no difference in the Individual group from pre-confidence scores to post-confidence scores. The $p\text{-value}=.12$ indicated the class in which students worked alone using computer assisted instruction had no effect on the confidence in the subject matter with this group of students. There was a significant difference in the scores in the cooperative learning group from the pre-confidence scores to post-confidence scores. The Paired Samples t-test revealed the $p\text{-value}=.01$ on the post-test which is less than $p=.05$. Therefore, the treatment in the cooperative learning group caused an increase in scores.

There was no significant difference in the mean scores of the pre-attitude test scores and the mean scores of the post-attitude test scores for the individual group. Therefore, the treatment had no effect on the students' perception of teachers' attitudes for this group of students. There was no significant difference in the mean scores of the pre-attitude test scores and the mean scores of the post-attitude test scores for the cooperative learning group. The scores for the individual group show no significant difference in the mean scores of the pre-cooperative test scores and the mean scores of the post-cooperative test scores. The treatment for this group had no effect on the students' attitude concerning cooperative learning. There was, however, the Paired Samples t-test revealed a significant difference in the cooperative learning group in students' attitude

toward cooperative learning from the pre-survey scores to post-survey scores. The p-value = .01 which was less than .05.

Table 6

Paired Samples t-test For the Individual Group and the Cooperative Learning Group on the Pre-and Post-Survey.

Group	Mean	Std. Deviation	t	df	Sig. (2-tailed)
Individual					
Pre-Confidence	30.67	9.34		23	
Post-Confidence	34.21	9.65	-1.59	23	.12
Pre-Attitude	32.54	6.11		23	
Post-Attitude	33.92	7.80	-.78	23	.44
Pre-Cooperative	39.71	10.50		23	
Post-Cooperative	39.96	11.27	-.11	23	.90
Group					
Pre-Confidence	35.22	10.84		26	
Post-Confidence	38.44	9.90	-2.72	26	.01
Pre-Attitude	33.04	8.71		26	
Post-Attitude	34.37	8.61	-.670	26	.50
Pre-Cooperative	41.26	8.43		26	
Post-Cooperative	45.56	8.21	-2.61	26	.01

Independent Samples t-test

An independent samples t-test was used to compare the mean scores of the cooperative learning group and the individual group in the areas of Students' Confidence in the Subject Matter, Students' Attitudes Concerning Cooperative Learning and Students' Perception of Teachers' Attitudes. There was no significant difference between the individual group and the cooperative learning group on Students' Attitudes Towards Cooperative Learning $p = .56$ on the pre-survey. The post-survey revealed there was a significant difference in students' attitudes toward cooperative learning for the cooperative learning group $p = .04$. In the area of Students' Confidence in the Subject the t-test revealed there was no significant difference between the individual group and the cooperative learning group on the pre-survey, $p = .12$. The t-test also showed there was no significant difference on the post-survey between the two groups with $p = .13$. In the area of Students' Perception of Teachers' Attitudes, the pre-survey showed there was no difference between the individual group and the cooperative learning group $p = .81$. The post-survey revealed again there was no significant difference between the two groups in the same area, $p = .85$.

Table 7

Independent Samples t-test for the Individual Group and the Cooperative Learning

Group on the Pre- and Post-Survey

Pre-Survey	Std.		t	df	Sig.
	Mean	Deviation			
Confidence in Subject Matter					
Individual	30.67	9.34			
Group	35.22	10.84	-1.59	49	.12
Attitude Toward Cooperative Learning					
Individual	39.71	10.50			
Group	41.26	8.43	-.58	49	.56
Perception of Teachers' Attitude					
Individual	32.54	6.11			
Group	33.04	8.71	-.23	49	.81
Post-Survey					
Confidence in Subject Matter					
Individual	34.21	9.65			
Group	38.44	9.90	-1.54	49	.13
Attitudes Towards Cooperative					
Learning	39.96	11.27			
Individual	45.56	8.21	-2.04	49	.04
Group					
Perception of Teachers' Attitude	33.92	7.80			
Individual	34.37	8.61	-.19	49	.85
Group					

Summary

This study was conducted in an effort to ascertain if using cooperative learning and computer assisted instruction would significantly increase mathematic achievement scores, compared to participants working alone using the same computer assisted instruction program. Additionally, a survey was given to all participants in the study to fill out at the beginning of the study and again at the end of the study to find out if their attitude towards mathematics and cooperative learning had changed.

At the conclusion of the study, (ANOVAs) were conducted to determine if there was a significant difference between the cooperative learning group and the individual group concerning their mathematic achievement scores. The pre-test revealed that both groups obtained very similar scores on the Accuplacer pre-test. However, the Accuplacer post-test showed there was a significant difference on mathematic achievement scores where the cooperative learning group outperformed the participants working alone using computer assisted instruction whose scores met the .05 alpha level of significance.

Also, a Paired Samples t-test was performed to determine if there was a significant difference in attitude towards mathematics and cooperative learning from the start of the study to the end of the study within each group. The results concluded there was not a significant difference in attitude in either group at the conclusion of the study, with neither group meeting alpha scores of .05. The results clearly indicate that participants in the cooperative learning group made the greatest gains in mathematics achievement scores. However, there was no change in the participants' attitude toward mathematics or cooperative learning.

An Independent Samples t-test showed there was not a significant difference between the cooperative learning group and the group working alone on the pre- and post-survey in the area of Students' Perception of Previous Teacher's Attitude, and Student's Confidence in the Subject Matter. There was however, a significant difference on the post-survey scores for Students' Attitude Toward Cooperative Learning. A more detailed discussion is presented in the next chapter.

CHAPTER 5

DISCUSSION

Introduction

The purpose of this study was to determine whether mathematics achievement scores in a college-level developmental mathematics class would increase when cooperative learning and computer-assisted instruction (CAI) were used simultaneously. The study, through the use of a survey, attempted to determine if the cooperative use of computers can change students' attitude towards mathematics, their attitude towards working in cooperative learning groups, and their attitude towards previous mathematics teachers. Four classes participated in the study, two classes were assigned to work individually using computer assisted instruction and two classes were assigned to work in cooperative pairs using computer assisted instruction. Prior to being placed in the MTH099 classes, which are developmental classes teaching basic arithmetic skills, students completed the Accuplacer pre-test. Fifty-one students completed the study, took the Accuplacer post-test, and again took the survey.

Research Results

This study was conducted to determine if there was an increase in mathematic achievement scores between participants working alone using CAI and students working in cooperative pairs using CAI. The study sought to answer three broad questions; would mathematics achievement scores increase using cooperative learning and CAI, would using cooperative learning and CAI change students' attitudes towards mathematics, and would their attitude change toward cooperative learning. Answers to each of these questions are presented in separate sections for the sake of clarity. For the purpose of

further discussion individual questions from the survey that have relevance to the outcome of the study may also be discussed.

Mathematic Achievement Scores

The current study is significant because there are very few studies involving higher education, and even fewer studies involving cooperative learning and CAI. There are no studies examining effects of mathematics achievement scores using cooperative learning and CAI in developmental mathematics programs in post-secondary education. Furthermore, this study focused on students enrolled in an art school as opposed to students enrolled in a traditional post-secondary institution.

Participants were required to take the Accuplacer pre-test prior to being enrolled in the developmental mathematics class. An analysis of the pre-test results showed there was not a significant difference in the mathematics achievement score between the participants working alone using CAI and the participants working in cooperative learning groups using CAI. Since there was not a significant difference it can be concluded the achievement level of all participants were equal at the start of the study. However, the results of the post-test disclosed there was a significant difference between the groups. Although, the results show a statistically significant difference between the two groups on the post-test, the actual difference in mean scores was rather small. An analysis was made to determine if there was an increase in mathematics achievement scores within each of the groups after a quarter of using CAI. The results showed there was a statistically significant increase in achievement scores from the pre-test to the post-test for each of the groups.

In this current study, the improvement in both groups point to the success of nine weeks of lecture and homework. The drill and practice received by all participants using CAI most likely also contributed to the significant increase in the mathematics achievement scores. Using CAI, participants were able to practice concept areas where students' skills were weak, thus increasing their knowledge. Not only did the cooperative learning group have a significant increase in mathematics achievement scores within the group, they also had a significant difference in mathematics achievement scores compared to participants working alone using CAI. The significant difference in mathematics achievement scores may be the result of the cooperative learning students' ability to discuss the mathematical problems and the various methods in which to solve them with each other. Reflection writing which the cooperative learning participants engaged in could also explain the significant increase in their mathematics achievement scores. The reflection writing allowed students to focus on what they learned during the class session and which mathematical problems were difficult for them. Reflecting on the problems that were difficult for the participants gave the student an opportunity to focus on the steps or the procedure used to solve the problem, thus allowing them to process the information in words that made sense to them. Often times, instructors will use vocabulary specific to the content area. The vocabulary makes sense to the instructor, but the student may be unfamiliar with the terms and may feel as though the instructor is speaking a foreign language. Therefore, the student spends time trying to process the vocabulary words, and does not pay attention to the rest of the process. It is also possible that by allowing students sufficient time to reflect on the procedures they used to solve mathematical problems they further develop the skills needed to successfully solve future

problems. Students in the group that worked alone using CAI did not do reflection writing. Halliday and Marr, (1995) advocated the use of journal writing for mathematics students, and stated that keeping journals allow the student to develop language and mathematical skills together. They further state that students are able to verbalize their thought processes, through journal writing. This enabled them to express emotional reactions and feelings about mathematics.

Another explanation for the significant increase in mathematics achievement scores for participants working in the cooperative learning group using CAI was the low absenteeism and tardiness rate compared to the students who were working alone using CAI. As stated in chapter three, the classes were divided into two sections, with 24 participants attending the individual group classes, and 27 participants in the cooperative learning classes. During the lecture portion of the class, the cooperative learning group missed a total of 58 hours of lecture and was tardy 7.75 hours, while the individual group using CAI were absent a total of 112 hours of lecture and was tardy 8.5 hours. The hours students were absent is almost double for the group working alone using CAI compared to students working in the cooperative learning group using CAI. The number of hours students in the individual group was absent for the computer portion of the class was more dramatic compared to the cooperative learning group for the lecture portion of the class. Participants in the cooperative learning group were absent a total of 50 hours for the computer portion of the class, and the participants in the individual group missed a total 136 hours. The number of hours missed by the individual group is more than double than the hours missed by participants working in the cooperative learning group. Participants in the cooperative learning group were late to class a total of 1.25 hours

compared to the individual group who were late to class a total of 7.25 hours. A possible explanation for the low absenteeism may have been the student's own feelings of not wanting to let his or her partner down by not attending the computer laboratory class. Although participants in the cooperative learning group were being graded using individual accountability, which means they were responsible to know the material and to take quizzes and tests on their own, they also received an average quiz grade of their quiz grade and their partner's quiz grade. The participants also received a grade for their cooperative work in the computer laboratory. It is possible the students did not want to feel responsible to their partner if the group received a low score for the computer portion of the class because he or she did not attend, or for a low average grade on the quiz. Finally, it is possible since participants signed a consent form to participate in the study they felt an obligation to attend the class. This does not, however, explain the high absenteeism rate for participants working alone using CAI, since they also signed a consent form to participate in the study.

Each of the classes involved in the study received the same instruction during the lecture portion of the class, which included PowerPoint slides with notes clearly displayed, and a written explanation on how to solve the mathematical problems for each of the concepts the students were expected to learn. There was no difference between the instruction received by the students working individually using CAI and the students working in cooperative learning groups using CAI, since they both received the PowerPoint notes, identical number of examples and the exact same examples during the lecture to ensure there were no differences between the classes.

The results of this study are in contrast to the findings of Crooks, Klein, Leader and Savenye (1998). Their study showed no effect on student performance on the post-test which assessed the learning of the information presented in the computer based instructional program. It was their conclusion that the achievement benefits attributed to cooperative learning in studies with younger children may not apply when adults use cooperative learning with computer based instruction. Brinkerhoff, Brush, and Klein, (2005) had similar results. Their study was a post-test only control group design. The overall achievement level for all participants was low. There are differences with these two studies compared to the current study. First, the study completed by Crooks, Klein, Leader and Savenye (1998), was executed using a psychology program in the computer laboratory, and there was no discussion as to whether or not there was any lecture involved. The study conducted by Brinkerhoff, Brush, and Klein (2005), was a post-test only design, again it is unknown if lecture was involved in this study. As stated previously, there have been no studies concerning cooperative learning using CAI in a developmental mathematics classroom. The current study examined mathematics achievement scores in a developmental mathematics classroom using a pre-post- test design. Another distinguishing factor in the current study is the use of journaling. The studies conducted by Crooks, Klein, Leader, and Savenye (1998), and the study by Brinkerhoff, Brush, and Klein (2005) made no mention of the use of journaling in their research. Finally, the type of cooperative learning used and the length of the study differ from those of the previously mentioned research. The current study used formal cooperative learning in its study, where students have the same group member for the entire length of the class, and the current research was conducted for the entire quarter

instead of just a few weeks, or a few lessons. It is unknown the type of cooperative learning that was used in other studies.

Additionally, participants in the cooperative learning group may have actually enjoyed the class with the freedom to carry on conversations and to discuss solutions to the mathematical problems. The significant difference in mathematics achievement scores obtained by the cooperative learning group compared to the group working alone could be explained by the procedures used by the cooperative learning group to solve the mathematical problems. Participants in the cooperative learning groups solved each of the mathematical problems by writing the problems in a spiral bound notebook, and then compared and discussed the answers with their partner prior to submitting the result. If both participants agreed, the answer was then submitted into the computer. If the answer was incorrect, the participants would compare their notes with each other, discuss the procedure used to solve the problem, and then tried alternative methods to find the correct solution. The ability to discuss different ways to solve mathematical problems with their partner allowed participants the freedom to explore alternative methods to solve the problems that they may not have been aware of. This finding is in agreement with Marshall (1995), who concluded that by allowing students to work together produced trust, integrity and results by building true consensus, ownership and alignment.

Participants working alone using CAI most often would not write down the problem to solve it. Instead they would often guess at the correct solution. Inserting the wrong answer multiple times would lead to frustration on the part of the student. The instructor would observe the growing frustration and suggest to the student to try writing down the problem and use a step by step approach to solving the mathematical problem. The

student would often disregard the suggestions made by the instructor and continue to work on the problems as they had before. This behavior led to further frustrations on the part of the student.

At the beginning of the study, participants in the cooperative learning groups were instructed on the techniques of using cooperative learning, and were given an opportunity to work in cooperative learning groups for one class session prior to the start of the study. At the end of the class session, students were comfortable in their groups and were discussing each problem. Many of the students said it felt like they were cheating by discussing the problems with other students. However, when students were in the computer laboratory, they were prepared with the skills to begin working with other students.

Participants who worked alone using CAI, had little or no discussion with other students about ways in which to solve a problem, even though the instructor never directed participants not to ask other students for help. Instead, participants working individually asked the instructor for assistance in solving problems more often than participants working in cooperative learning groups. This is likely due to the fact that the students in the cooperative learning groups were familiar and comfortable with their partners, and were not shy about asking their partner for help. Participants working individually rarely interacted with the other members of the class. The participants who worked alone in the computer laboratory also worked alone in the lecture classroom, with very little communication among the students, which reinforces the belief that some students feel isolated in a classroom. The familiarity shown in the computer laboratory by the cooperative learning group extended into the lecture classroom. Students would enter

the room and sit near their computer partner, and during the practice of examples they would freely discuss their answers with not only their partner, but with other students sitting near them.

Students' Confidence in Subject Matter

The first section of the survey examined was "Students' Confidence in Subject Matter." As shown in chapter 4, The Independent Samples t-test showed there was no significant difference in the results from the pre-survey to the post-survey between the cooperative learning group and the group who worked alone. A natural assumption would be students did not feel confident in their ability to be successful in mathematics, since they were enrolled in a basic mathematics class. Upon a closer inspection of the survey, over three-fourths of the students working individually using CAI responded positively to the first statement "I can learn math." Participants in the cooperative learning group had an equally strong showing with just one percent shy of three-fourths of the students saying they can learn math. It is quite interesting that students who were enrolled in a basic mathematics course still felt confident they had the ability to do mathematics. It is difficult to determine what type of mathematics students were identifying with when they answered this statement. The attitudes of the students believing they have the ability to learn math, may in fact influence their performance within the class. It is likely that because participants believed they could learn math, they were willing to put forth effort to be successful. On the other hand, if they truly believed they could learn mathematics, then a logical conclusion would be they were more than capable to do basic arithmetic. Instead, the participants in this study did not achieve scores which allowed them to be placed into more advanced mathematics classes.

The post-survey revealed a response that was even higher than the pre-survey. The results to the statement “I can learn math” indicated that participants in both groups who were confident with their skills on the pre-survey remained confident throughout the course. Participants in the cooperative learning group who were not as confident in their ability to learn mathematics became more confident by the end of the study. The percent of students working alone using CAI, who answered strongly agree did not change; however, there was an increase in the response received by those who answered somewhat agree on the post-survey to the statement “I can learn math.” This increase in a positive response would point toward the assumption that students gained confidence in their mathematics ability throughout the course. It is difficult to know whether the confidence gained by the participants was the result of the lecture portion of the class, the computer portion of the class, or the combination of both. These results indicate participants’ attitude towards learning mathematics was positive and continued to be positive through the end of the study.

Since the statement “I can learn math” is a very general statement and could refer to any type of mathematics, a look at the statement “I can learn Algebra,” which is a much more specific term, was analyzed. More than half of the participants working alone using CAI, and participants in the cooperative learning group using CAI, believed they had the ability to learn Algebra. While participants were not as confident in their responses for “I can learn Algebra,” as they were with “I can learn math,” indications were the participants gained confidence in their ability as the quarter progressed. Overall, the results concluded that there was an increase in confidence and attitude by the students in

their mathematical abilities. Although the survey did show some increase in the “Students’ Confidence in the Subject Matter,” the growth was not significant.

Some explanations that most likely explain the “Students’ Confidence in the Subject Matter,” are only conjecture since there was no focus group to specifically ask the participants questions concerning their responses. One possible explanation is the amount of time students have been out of school. It is well known that many mathematical concepts are forgotten if they are not used on a regular basis. Therefore, if a student has been out of school for any length of time and not using mathematics, then chances are he or she has forgotten much of what he or she had learned in the past and it has become necessary to refresh their memory. The result of the survey would be especially true if the student had been successful in the past, as a result, he or she knows they were successful before and assumes they will be successful again. Another possible explanation was the student’s own attitude while taking the placement test. In the past, many students have admitted they did not do their personal best on the placement test. Reasons for this vary from they were very tired to they didn’t realize the test would determine which mathematics class they would be placed in. Since these explanations were expressed in the past, it is reasonable to conclude at least in part, that some of the students may have had similar experiences. Therefore, the student would have the confidence to know that he or she can learn mathematics. Finally, physical reasons may have been a factor for scoring low on the placement test, and for being placed in a basic mathematics course. It is not known whether the student felt well during the placement test, or was the student ill on the day he or she was expected to take the placement test. Another possible explanation could have been the student was tired from driving long distances to meet

with the admission representative and to take the placement test. These factors could contribute to the low scores and being placed in a basic mathematics class, and for the high percentage of students who were confident they could learn mathematics. However, the scores on the pre-test reveal a similar result for each group.

Students' Attitudes Concerning Cooperative Learning

The results of the survey revealed there was a significant difference in "Students' Attitudes Concerning Cooperative Learning" between the group working alone using CAI and the cooperative learning group using CAI. A possible explanation may be the way in which the computer classroom was implemented.

Historically, cooperative learning was used most often in grades K-12, while the post-secondary classroom was most often lecture based. The instructor talked and the student took notes, he or she could spew back to the instructor through quizzes and tests the information they were given. Cooperative learning is not often used in the post-secondary classroom, and even less often combined with CAI. The most likely explanation for not using cooperative learning could be the lack of training to implement such a program. While most colleges provide professional development for their faculty, the training is often in the area pertaining to what the instructor is currently teaching, or the most recent research findings. Since there is little current research for cooperative learning in higher education, it would not be an area of professional development. Time might also be a factor for not implementing cooperative learning in the post-secondary classroom. Instructors must adhere to a fairly rigid schedule in order to cover all of the required material in a semester or quarter. Instructors may feel adding one more thing to their schedule would be too overwhelming, and would not permit them to cover all the

required material. However, some post-secondary instructors may assign group work with the misconception they are using cooperative learning. Even in the K-12 classroom, cooperative learning, in many instances, has not been properly executed. Assignments that are called cooperative learning are nothing more than group work, where one or two students do all the work, but the entire group received the same grade. The past experiences students have had with “cooperative learning” could possibly explain the attitude that was revealed on the pre-survey. The significant positive increase in “Students’ Attitude Towards Cooperative Learning” by the cooperative learning group most likely was the direct result of experiencing a properly executed cooperative learning program, where the work was equally shared by both partners, and the grade received was earned by each student individually through quizzes and tests. The knowledge that each person shared had equal responsibilities, and seeing positive results on the participants quiz and test grades may have resulted in the significant difference on the post-survey. The increase of scores for the cooperative learning group is interpreted as a direct result of working in cooperative pairs throughout the quarter. The pre-survey results for the group working alone and the cooperative learning group was very low on the pre-survey, which would indicate that participants in the study were not successful in the past working in cooperative learning groups, or they were not exposed to it before.

The results for “Students’ Attitudes Concerning Cooperative Learning,” revealed there was no significant difference in the mean scores of the pre-cooperative scores and the mean scores of the post-confidence scores for participants in the individual group. Therefore, the treatment of working alone using computer assisted instruction had no effect on the students’ attitudes concerning cooperative learning.

Students' Perception of Teacher's Attitudes

Reviewing the results for “Students' Perception of Teachers Attitude,” revealed there was no significant difference in the mean scores of the pre-attitude scores and the mean scores of the post-attitude scores for the individual group. Therefore, the treatment had no effect on the students' perception of teachers' attitudes for this group of participants. Also there was no significant difference in the mean scores of the pre-attitude scores and the mean scores of the post-attitude scores for the cooperative learning group. Consequently, the treatment had no effect on the students' perception of teachers' attitudes for either group. Reviewing the results between the individual group and the cooperative learning group showed there was no significant difference of “Students' Perception of Teachers' Attitudes.”

This section is historical in nature and a change in student's perception of their previous mathematics teacher's attitude was not expected. An expected result of this survey was that students' believed their previous mathematics teachers did not have confidence in the student's ability to do well in mathematics, or previous teachers did not encourage the student to do better. Neither of these expectations was true. Students believed their previous mathematics teachers did express to them their belief he or she could learn mathematics, and the previous mathematics teachers did encourage the student to do better. The result of the survey did not imply any fault to previous mathematics teachers for the student's being placed in a basic mathematics classroom in college.

Conclusion

Each group did show improvement in their mathematics achievement score, however, the significant difference in the pre- and post-test scores between participants working individually using CAI and participants working in cooperative learning groups using CAI supports the conclusion that using cooperative learning and computer assisted instruction will improve mathematic achievement scores to a greater degree. The study included computer assisted instruction which gave students the opportunity to focus on concept areas where participants showed weakness. This is unquestionably the reason both groups displayed an increase in mathematic achievement scores. The significant difference in scores found with the cooperative learning group could be explained by the dialogue students engaged in on various methods to solve mathematics problems that made sense to them. Also, using paper and pencils to solve the question posed to them, the students were able to visually see the process used to solve a mathematical problem, and perhaps to see the mistakes that were made while solving them. Finally, by having the cooperative learning group reflect on their work and write their reflections in journals, students had time to reflect on what they learned during the computer session, what concept gave them the most troubles, and what steps were used to overcome them. It also gave participants time to relate the mathematical problems into real world situations, which would provide them with more motivation to seek solutions.

There may be some alternative reasons for the significant difference in the mathematic achievement scores. First, it is possible that not all of the students did their best on the Accuplacer pre-test, and as a result were enrolled in the MTH099 class instead of MTH100 or a college level mathematics course. Second, students in the cooperative

learning group may have been more interested in learning the mathematical concepts rather than just quickly going through the lessons that were on the computer. Finally, the level of student confidence, persistence and effort could have been higher in the cooperative learning group than of those in the group that worked alone. However, confidence, persistence and effort are variables that cannot be easily measured.

Limitations of the Study

The Art Institute of Pittsburgh operates on a quarterly basis; therefore, the study was relatively short. While the quarter is 11 weeks in length, there was a holiday which gave the students 10 weeks to use computer assisted instruction. The study ended one week prior to the end of the quarter, so the study was actually completed in nine weeks. Also, the classes involved in the study met at different times of the day. Two of the classes met in early afternoon, twice a week, and two of the classes met for four hours once a week beginning at 6:00 p.m. A fifth class was not part of the study and was conducted using a regular class structure. The exclusion of the fifth class is due in large part to the logistics of the room set-up and scheduling. Finally, the researcher was also the instructor for both groups. Implications of this include the possibility of providing more information to one group than the other group, and providing more assistance to one group than the other group in the computer laboratory.

Future Research

Additional research conducted at the higher education level specifically with developmental courses is strongly recommended. In particular it would be interesting to examine if the mathematics achievement scores would continue to show a significant increase using cooperative learning paired with computer assisted instruction in a study

over several semesters or quarters obtaining a larger sample. Also a study should be conducted measuring the effects of mathematics achievement scores in relations to absenteeism, since this study revealed a significant difference in the absenteeism rate between participants in the cooperative learning group and participants in the group working individually. Research in a college mathematics course is needed to determine if the same results would occur, or are the results from this study confined to developmental mathematics. Additionally, a study that looks at the rates of success among developmental mathematics students over the course of their post-secondary education would be an area to explore. Furthermore, a study examining mathematics achievement scores by looking at gender to determine if gender still impacts mathematics achievement scores.

Future studies using the various types of cooperative learning is needed to compare results as well. It is unknown if the various types of cooperative would produce the same results, or are the results limited to formal cooperative learning. Another potential study would be journaling and the effects it has on a mathematics achievement scores. Journaling has been recommended for several years, but a study to determine the effects, if any, journaling has on mathematics achievement scores is not known. Finally, forming focus groups with the students at the beginning of the study and at the end of the study might clarify the responses of participants, since it is difficult to know what the students were thinking as they answered the statements on the survey.

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Appendix A

The Art Institute of Pittsburgh

The Art Institute of Pittsburgh is a wholly owned subsidiary of the Art Institutes, one of the nation's leaders in postsecondary career-orientated education for creative and applied arts. The Art Institute of Pittsburgh was founded in 1921 as the Artists League of Pittsburgh. The first commercial art school east of Chicago began classes in a 500 square-foot space. A single instructor taught nine students drawing, painting, lettering and cartooning. In 1929, the school's name was changed to The Art Institute of Pittsburgh. The student body had grown to 500 students enrolled in commercial art and fashion illustration diploma programs. During its first decade, the school had moved four times and was now located on Stanwix St.

The Art Institute of Pittsburgh barely survived the depression, but flourished in the 1940's and 1950's due primarily to the large number of veterans who decided to pursue an education in commercial art. By 1945, the Institute occupied an 8 story building and served 1700 students from 40 states and five countries. Interior Design, Dressmaking, Millinery Design and Photography were added to the original curricula in both day and evening classes.

During the 1950's and 1960's enrollment declined then remained at a level of 600 to 700 students until 1969, when the Institute became affiliated with Educational Management Corporation. In the 1970's, the Institute achieved accredited status with the National Association of Trade and Technical Schools, now recognized as The Accrediting Commission of Career Schools and Colleges of Technology. Fashion Marketing, Interior Design, and Photography were added to the school's academic

majors, and all programs were reviewed by the Pennsylvania Department of Education, and approved to award the Associate of Specialized Technology Degree (AST). The Art Institute of Pittsburgh began the development of the College Affiliate Program, and greatly expanded services to students. By 1980, enrollment had reached 1,500 students. Moderate growth continued throughout the 1980's until the 1988-89 school year when the Industrial Design Technology and Music and Video Business programs began and were approved for degree granting status. An increased effort to attract international students was initiated. Desktop Publishing was added in 1991, nearly doubling the diploma program enrollment. In 1991, The Art Institute of Pittsburgh reached a record enrollment of 2,600 students. In 1993, the Institute developed and secured approval from the State Board of Private Licensed Schools to offer programs in Computer Animation/Multimedia and Artisan Technology. In 1995, The Art Institute was approved to offer the Video Production and Multimedia and Web Design programs. However, The Art Institutes realized they would have to offer academic degrees in order to continue growing.

Appendix B
Attitude Survey
Student Identification Number_____

Please answer the following questions. Circle the number which correctly describes you.

Gender:

- 1. Male**
- 2. Female**

Age:

- 1. 18-25**
- 2. 26-30**
- 3. over 30**

Quarter you are currently enrolled:

- 1. First**
- 2. Second**
- 3. Third**
- 4. Other**

Program of Study:

- 1. Advertising**
- 2. The Art of Cooking**
- 3. Culinary Arts**
- 4. Culinary Management**
- 5. Digital Design**
- 6. Digital Media Production**
- 7. Game Art & Design**
- 8. Graphic Design**
- 9. Industrial Design**
- 10. Interactive Media Design**
- 11. Interior Design**
- 12. Media Arts & Animation**
- 13. Photography**
- 14. Residential Planning**
- 15. Video Production**
- 16. Visual Effects & Motion Graphics**
- 17. Web Design**

Which program are you enrolled:

- 1. Associates Degree**
- 2. Bachelor Degree**

Appendix B Attitude Survey

Math Attitudes

Below is a series of sentences. Please circle the response that best agrees with how you feel for each statement. Do not spend much time with any statement, but be sure to answer every statement. There is no right or wrong answers. The only correct responses are those that are true for you. Use your past experiences to guide your selection. The groups have already been selected. Your answers will not determine whether you are placed in the cooperative learning group or the individual learning group.

Student Confidence about the Subject Matter

	Strongly Agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly Disagree
1. I can learn math	1	2	3	4	5
2. Algebra would be difficult for me	1	2	3	4	5
3. Math is hard for me	1	2	3	4	5
4. I am confident of my math skills when I solve math problems	1	2	3	4	5
5. I'm not the type to do well in math	1	2	3	4	5
6. Math has been my worst subject	1	2	3	4	5
7. I can learn Algebra	1	2	3	4	5
8. Other subjects are easier to learn than math	1	2	3	4	5
9. I can get good grades in math	1	2	3	4	5
10. I know I can do well in math	1	2	3	4	5
11. Algebra is easy for me	1	2	3	4	5
12. I'm not good at math	1	2	3	4	5

Teachers Attitudes

	Strongly Agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly Disagree
13. My Previous math teachers have been interested in my progress in math	1	2	3	4	5
14. My previous math teachers believed in my ability to do math	1	2	3	4	5
15. My previous math teachers spent extra time helping me to learn math	1	2	3	4	5
16. My previous teachers have encouraged me to take additional math courses	1	2	3	4	5
17. I have a hard time getting teachers to talk with me about math	1	2	3	4	5
18. My previous math teachers have discouraged me from taking algebra	1	2	3	4	5
19. Previous math teachers ignored me when I asked questions about math	1	2	3	4	5
20. My teachers encouraged me to take all the math I can	1	2	3	4	5
21. Previous math teachers have told me I have the ability to do algebra	1	2	3	4	5
22. My previous teachers have told me I cannot do well in math.	1	2	3	4	5

Students Attitudes Concerning Cooperative Learning

	Strongly Agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly Disagree
23. I understand math concepts better when they are explained to me by my peers	1	2	3	4	5
24. Working with other students makes learning math fun	1	2	3	4	5

	Strongly Agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly Disagree
25. When working on math in a group of 2 or more people I do my share of work	1	2	3	4	5
26. In the past when working on math in a group of 2 or more people each person shared responsibility e equally to complete tasks	1	2	3	4	5
27. In the past, my grades improved as a result of working in a group of 2 or more people	1	2	3	4	5
28. I prefer to work with at least one other person	1	2	3	4	5
29. I do not understand math concepts when they are explained to me by my peers	1	2	3	4	5
30. Working with other students does not make learning math more fun	1	2	3	4	5
31. In the past when working on math in a group of 2 or more people I let the others do most of the work	1	2	3	4	5
32. In the past my math grades did not improve as a result of working in a group of 2 or more people	1	2	3	4	5
33. I prefer to work on my math assignments alone	1	2	3	4	5
34. In the past when working on math assignments in a group of 2 or more people, one or two people most of the work	1	2	3	4	5

Appendix C

On October 25, 1996, the U.S. Department of Education published its list of approved tests in the Federal Register. The College Board Accuplacer Reading Comprehension, Sentence Skills and Arithmetic tests were approved for ATB purposes.

There is a pool of test items that have been calibrated for difficulty and content. The first question presented is of average difficulty and is chosen randomly from several starter questions of the same level of difficulty. If a student answers the question incorrectly, the next question to be administered is chosen from a group of easier questions, whereas a correct answer will cause the next problem to be somewhat more difficult. Because of the adaptive nature of the tests, the questions presented on successive tests will vary, thereby greatly reducing the effects of repeated practice on the tests. The elimination of repeated questions will be even more marked as time passes and the student's skills change. Scores for the tests are reported on a 120 point scale and represent an estimate of the score students could expect to receive if they had taken a test of 120 questions. The percentile rank indicates student performance in relation to a normative sample of test takers. For the Accuplacer tests, the normative population was composed of college entry level students at both two and four year colleges. The standard error of measure corresponding to a particular score shows the accuracy of the measurement. Statistically, two thirds of the examinees will have true levels within the one standard error of measure. Accuplacer presents the tests in a computer-adaptive mode, which benefits the students and the administrators with quick and accurate testing. Accuplacer test scores are available immediately. If students successfully finish the arithmetic portion of the test, they move directly to elementary algebra.

The arithmetic test contains 17 questions, which are divided into three types:

Operations with whole numbers and fractions: topics included in this category are addition, subtraction, multiplication, division, recognizing equivalent fractions and mixed numbers and estimating; 2) Operations with decimals and percents: topics include: addition, subtraction, multiplication, and division with decimals. Percent problems, recognition of decimals, fraction and percent equivalencies, and problems involving estimation is also given; 3) Applications and problem solving: topics include rate, percent, and measurement problems, simple geometry problems and distribution of a quantity into its fractional parts. Twelve questions are in this section and are divided into three types.

First, operations with integers and rational numbers, and including computation with integers and negative rational numbers, the use of absolute values, and ordering. These questions test minimal skill levels of the student. A second type, which involves operations with algebraic expressions, tests minimal skill levels using evaluation of simple formulas, expressions, adding, subtracting monomials and polynomials. At all skill levels, questions are provided involving multiplying and dividing monomials and polynomials, the evaluation of positive rational roots, exponents, simplifying algebraic fractions, and factoring. The third type of questions involves the solution of equations, inequalities, and word problems. As in the arithmetic section, few questions are presented from this category unless the student demonstrates skill in this area. If a student is able to continue he or she is then given questions regarding solving linear equations and inequalities, the solution of quadratic equations by factoring, solving verbal problems presented in an algebraic context, including geometric reasoning and graphing, and the

translating of English phrases into algebraic expressions. Depending on the skill of the student, he or she may continue testing in the College Level Mathematics Test (CLMT). Twenty questions are administered in the CLMT. CLMT determines the proficiency in intermediate algebra through pre-calculus. The institution uses the data to place students into intermediate algebra, college algebra, and pre-calculus or introductory calculus courses.

Appendix E
Letter to Students

January 10, 2005

Dear Student,

My name is Kathy Griffin. For those who do not know me, I am one of the faculty members at Art Institute. I am a student myself as I am enrolled in a doctoral program in education at Duquesne University.

One of the requirements of my program is the design and completion of a dissertation project. This project represents my original research in an area of interest within education. I am particularly interested in different types of teaching and learning environments. For my dissertation research, I am curious to learn more about cooperative learning and individual learning with the ALEKS Mathematics Package. You will be using this package this quarter in your Math 099 course. I am interested in learning whether students are more successful in learning math skills when they work individually or in cooperative groups.

You have already been assigned to a math 099 section. All math 099 students will use the ALEKS program. Some sections will use a cooperative learning format and other sections will use an individual learning format to cover content.

The reason I am contacting you now is to determine your willingness to participate in my research. If you agree to participate, I will ask you to complete a set of questionnaires to provide me with some information at the beginning of the quarter and at the end of the quarter. The information is directed towards learning styles and attitudes. I will also ask you to complete a brief pre and post-test of your math knowledge.

Your participation in this research project is completely voluntary. A decision to participate or not to participate will in no way affect your experience in the course or your course grade. Confidentiality of your identity will be insured, as I will not use names when gathering or reporting information. I plan to obtain at least 15 students in each section for my project and would certainly appreciate your willingness to participate.

Please feel free to contact me at (412) 291-6479 if you have any questions about my project. I will begin the project week two of the quarter and will continue through week 10.

Thank you for your consideration.

Sincerely,

Kathy R. Griffin

Appendix F Consent Form



DUQUESNE UNIVERSITY

600 FORBES AVENUE ♦ PITTSBURGH, PA 15282

CONSENT TO PARTICIPATE IN A RESEARCH STUDY

TITLE: Math Achievement Scores: Success Rates of Cooperative Learning Groups and Individual Learning using Computer Assisted Instruction in a Developmental Math Class.

INVESTIGATOR: Kathy R. Griffin,
1015 Voskamp St.
Pittsburgh, Pa. 15212
(412) 321-2169

ADVISOR: Dr. William Barone
School of Education
(412) 396-5569

SOURCE OF SUPPORT: This study is being performed as partial fulfillment of the requirements for the doctoral degree in School of Education at Duquesne University,

PURPOSE: You are being asked to participate in a research project that seeks to investigate whether **math achievement scores increase when you work individually or in cooperative learning groups on the computer. You will be required to complete the regularly scheduled work as it is spelled out in your syllabus. In addition to this work, you have already taken the Accuplacer pre-test and will be required to take the Accuplacer post-test of your math skills. The amount of time required to complete this test is dependent upon the number of questions given to you by Accuplacer. In addition to these requirements, you will be asked to complete a survey measuring your attitudes towards math and cooperative learning, the survey will be given during class time and will take approximately 30 minutes to complete.** These are the only requests that will be made of you.

RISKS AND BENEFITS: **There is minimal risk involved in this study. There is no greater risk than would normally occur participating in a math class. There may be a benefit to you by improving your math scores by participating in this study.**

COMPENSATION: **The participants will not be compensated in any way.**

CONFIDENTIALITY: You will be asked to put your Student Identification number at the top of the survey. A third party who is not affiliated with The Art Institute of Pittsburgh will record your Identification number and

assign another number to the survey which will also be recorded next to the corresponding student identification number. The survey responses will be connected with achievement tests scores that have names attached, but will remain confidential at all times. Any data that is collected through the survey or achievement tests will be used in the published data. All materials pertaining to this study will be kept in a locked file at the researcher's home for a period of five years.

RIGHT TO WITHDRAW:

You are under no obligation to participate in this study. You are free to withdraw your consent to participate at any time. In the event you withdraw from the study, the data collected will not be used in the study. In no way will refusal to participate in this research project affect the outcome of your grade.

SUMMARY OF RESULTS:

A summary of the results of this research will be supplied to you, at no cost, upon request.

VOLUNTARY CONSENT:

I have read the above statements and understand what is being requested of me. I also understand that my participation is voluntary and that I am free to withdraw my consent at any time, for any reason. I further understand that by consenting to participate I am granting permission to the researcher to use my quiz scores, test scores, pre and post test scores, survey results, and any other data deemed necessary to complete the study. On these terms, I certify that I am willing to participate in this research project.

I understand that should I have any further questions about my participation in this study, I may call the researcher whose information appears at the beginning of this consent form or I may contact Dr. Paul Richer, Chair of the Duquesne University Institutional Review Board (412-396-6326).

Participant's Signature

Date

Researcher's Signature

Date